

FOIA MARKER

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EPA [Environmental Protection Agency] Energy Star - By State(s)

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 \$127 million will be saved by Connecticut companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



More ENERGY STAR Facts

- Connecticut is home to 87 companies and public entities participating in ENERGY STAR partnerships.
- Over 110 million square feet of Connecticut building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 925 times the size of Foxwoods Casinos.
- 10 ENERGY STAR-Labeled Product manufacturers are located in Connecticut.
- Investments already made through the ENERGY STAR program in Connecticut will prevent over 3 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 480,000 acres of trees — an area 110 times the size of the University of Connecticut-Storrs.
- Nitrogen oxide (NO_x) emissions will be reduced by 4 million pounds and sulfur dioxide (SO₂) by 12 million pounds due to existing ENERGY STAR investments in Connecticut.

Highlights

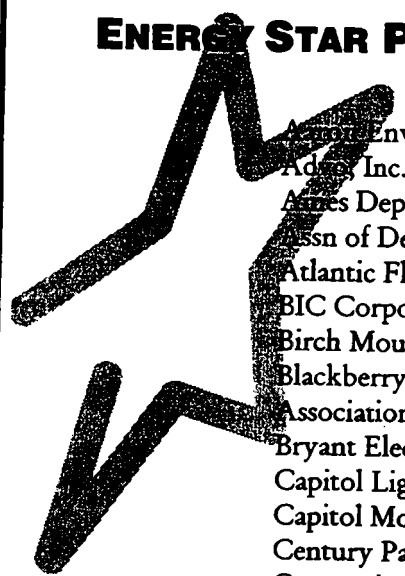
- Pitney Bowes received the ENERGY STAR Office Equipment Best External Promotion Award in 1997 and Facsimile Partner of the Year in 1996.
- Xerox received the ENERGY STAR Office Equipment Best Promotion Award in 1998.

Market Potential

- Connecticut has 960 million square feet of ENERGY STAR Buildings- upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$330 million would be saved annually
 - The following emissions would be prevented each year:
 - 7 billion pounds of CO₂
 - 11 million pounds of NO_x
 - 32 million pounds of SO₂

CONNECTICUT

ENERGY STAR Participants in Connecticut



Adams Environmental	Kenyon Oil Company
Adco, Inc.	Konica Business Machines USA, Inc.
Ames Department Stores Incorporated	LighTech Resources, LLC
Assn of Demand-Side Mgt Professionals	Makein Friend
Atlantic Fluidics Inc	Manor House
BIC Corporation	Masonic Geriatric Healthcare Center
Birch Mountain Pottery	Meadow Works
Blackberry River Inn	Mohegan Tribal Nation
Association of Bridal Consultants	New Haven Plumbing Supplies
Bryant Electric	National Association of Electrical
Capitol Light and Supply Company	Distributors
Capitol Moving & Storage	New Canaan YMCA
Century Parties Inc	Nikken
Connecticut Business & Industry	North American Energy Systems
Association	Northeast Utilities
Connecticut College	Norwalk Medical Group
Connecticut Mutual Life Insurance Home	Old Mystic Inn
Office	Pathway Lighting Products, Inc.
Conservation Alliance	Patriot Wire Products Incorporated
Directional Technologies, inc	Pequot Hotel B & B
Dual-lite	Phoenix Home Life Mutual Insurance Co.
Dex Business Systems	Pitney Bowes, Inc.
The Dexter Corporation	Prolume Corporation
Duracell	Quality Lighting
Dynaray Emergency Lighting	Retrofit Design Lighting
Dynergie	Savin Corporation
ERI Services, Vernon	Selfani Brothers of Crescent
Easton Consultants	Sensor Switch
Edmunds Gages	Stonecroft Country Inn
Efficient Lighting & Maintenance	TSAO Designs and CSL
Incorporated	The Carpenters Kid
Emergi-Lite	Total Lighting Service, L.L.C.
Executive Companies Incorporated	Connecticut Army National Guard
Town of Fairfield, CT	(State/Fed Space Included)
Federated Garden Clubs of Connecticut	USES, Inc.
Foxwoods Resort and Casino	United Illuminating Company
G Leslie Sweetnam	University of Connecticut
GTE	Vistech Corporation
Evelyn Gerr	Vista Lighting
Grand Light & Supply Co., Inc.	Wesleyan University of Connecticut
Greenwich Chrysler	Witco Corporation
Hebrew Home & Hospital	Xerox Corporation
High Lites Inc.	Yale University Arts and Sciences Campus
Hubbell, Inc./Wiring Device Division	
ITT Hartford Group, Incorporated	
JJI Lighting Group, Inc.	
James Leslie Parker	
The Jewish Home for the Elderly	
Karen's Krafts	

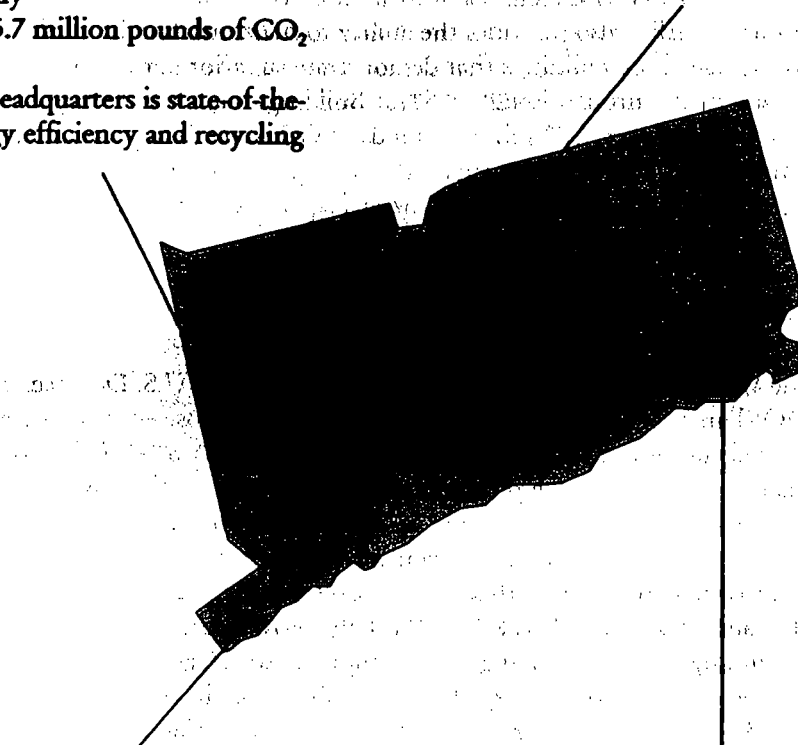
Examples of Connecticut Partners Saving Money and Helping the Environment

Connecticut Mutual Life Insurance, Hartford

- Saving \$150,000 in annual energy costs
- Cut lighting costs in half
- Reducing energy use by 2.5 million kWh annually
- Preventing 4 million pounds of CO₂ annually

Duracell, Bethel

- Saving \$157,000 in annual energy costs
- Upgraded lighting for 1 million sq. ft.
- Reducing energy use by 2.6 million kWh annually
- Preventing 5.7 million pounds of CO₂ annually
- Corporate headquarters is state-of-the-art for energy efficiency and recycling



Foxwoods Resort and Casino, Ledyard

"We will attend Green Lights seminars and workshops and utilize anything else the program offers whenever it can benefit our conservation efforts."

— Sal Scheri, Director of Engineering

Xerox Corporation, Stamford

- Saving \$457,000 in annual energy costs
- Upgraded 18% of its square footage (23 million sq. ft.)
- Reducing energy use by 8.2 million kWh annually
- Preventing 12.4 million pounds of CO₂ annually

- Saving \$427,000 in annual energy costs
- Completed lighting upgrades for 2.25 million sq. ft.
- Reducing energy use by 6 million kWh annually
- Preventing 10 million pounds of CO₂ annually
- Committed to energy efficiency in all new construction

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Connecticut

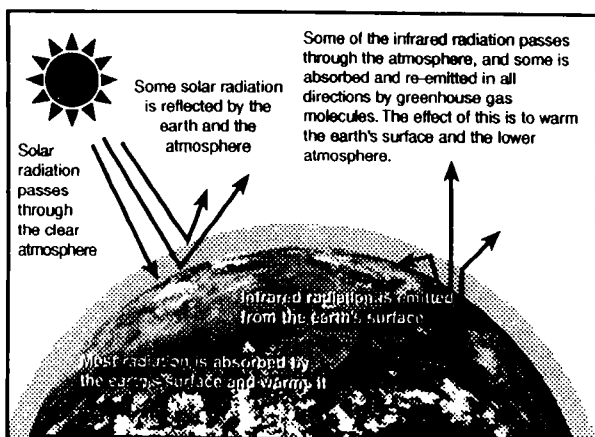
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

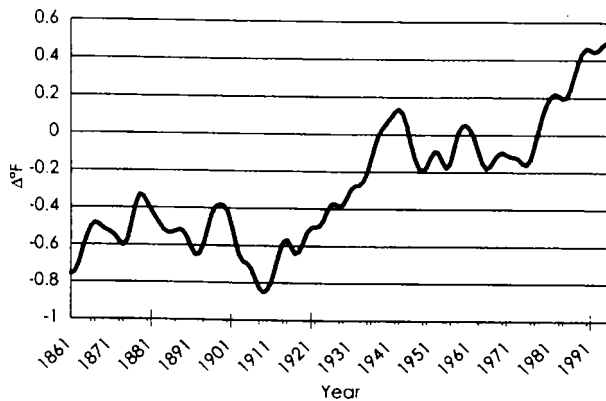
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F since the late 19th century. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4–10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that *“the balance of evidence suggests a discernible human influence on global climate.”*

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6–6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6–38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

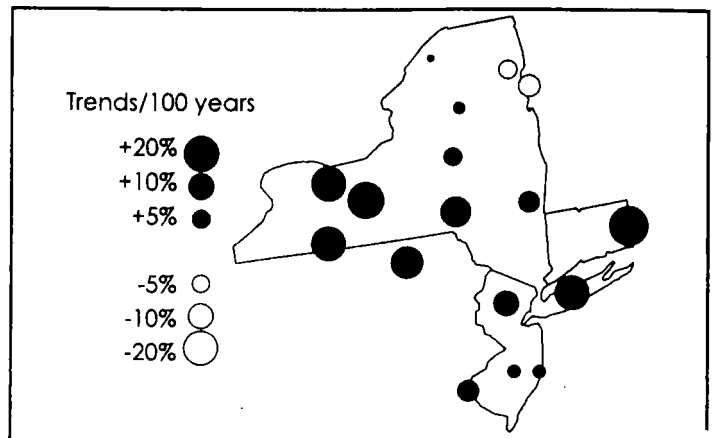
Local Climate Changes

Over the last century, average temperatures in Storrs, Connecticut, have increased from 45.8°F (1892–1921 average) to 48.2°F (1966–1995 average), and precipitation in some locations has increased by 20%.

Over the next century, Connecticut’s climate may change even more. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Connecticut could increase about 4°F (with a range of 2–8°F) in all seasons. Precipitation is projected to increase by 10–20% (with a range of 0–40%), with slightly less change in spring and summer and slightly more in winter.

The amount of precipitation on extreme wet (or snowy) days most likely would increase, but changes in the lengths of wet or dry spells are not clear. The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms such as hurricanes would change, although an increase in the frequency and/or intensity of winter storms is possible.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Connecticut, with its irregular, intense heat waves, may be especially susceptible.

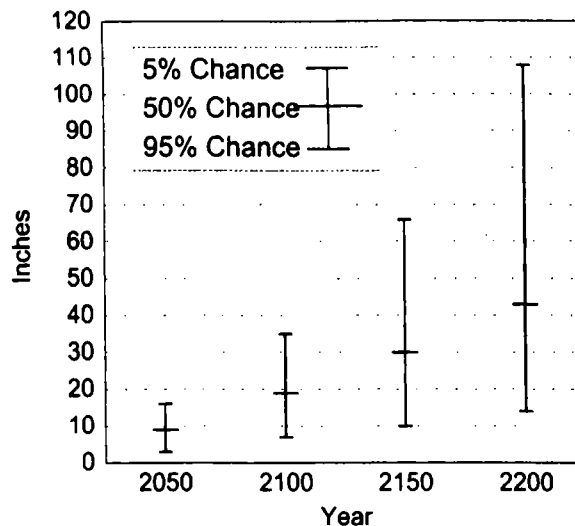
In Hartford, one study projects that a 2°F warming could increase heat-related deaths during a typical summer by about 20%, from close to 40 heat-related deaths per summer to near 50 (although increased air conditioning use may not have been fully accounted for). Winter-related deaths are expected to change very little if the temperature warms by 2°F. The elderly, particularly those living alone, are at greatest risk.

There is concern that climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbons emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

A 4°F warming in New York City, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by 4%. Similar increases could be expected in Connecticut. Currently, ground-level ozone concentrations exceed national ozone health standards throughout the state. All of Connecticut is classified as a "serious" nonattainment area for ozone. Ground-level ozone has been shown to aggravate respiratory illnesses such as asthma, reduce existing lung function, and induce respiratory inflammation. In addition, ambient ozone reduces crop yields and impairs ecosystem health.

Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitos flourish in some areas around Connecticut. Some can carry malaria, while others can carry Western equine encephalitis, which can be lethal or cause neuro-

Future Sea Level Rise At New London



Source: EPA (1995)

logical damage. Lyme disease, which is carried by ticks, has increased in Connecticut. If conditions become warmer and wetter and thus support larger populations of mosquitos and ticks, these diseases may be transmitted more widely.

In addition, warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. These blooms damage habitat and shellfish nurseries, can be toxic to humans, and can carry bacteria like those causing cholera. Brown algal tides and toxic algal blooms already are prevalent in the Atlantic. Warmer ocean waters could increase their occurrence and persistence.

Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

Along much of Connecticut's coast, sea level already is rising 8 inches per century, and it is likely to rise another 22 inches by 2100. Connecticut's coastline contains valuable residential development and important wetlands ecosystems that would be vulnerable to flooding from sea level rise. In particular, Connecticut has extensive tidal flats and diverse nontidal freshwater marshes. Because Long Island Sound may reduce wave action, some of these wetlands may be protected with a temporary buffer from erosion. Connecticut's freshwater marshes, however, are likely to be harmed by saltwater intrusion.

Cumulative costs through 2100 to protect Connecticut's coastline from a 20-inch sea level rise could be \$0.5-\$3 billion.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

The Connecticut River is susceptible to changes in winter snow accumulation, which would be reduced in a warmer climate. Peak spring streamflows in the Connecticut River could occur several weeks earlier if the climate were to warm about 4°F. The Missouri and Thames rivers could see similar but smaller changes. Without increased precipitation, groundwater would decrease in a warmer climate, which would reduce Connecticut's aquifers.

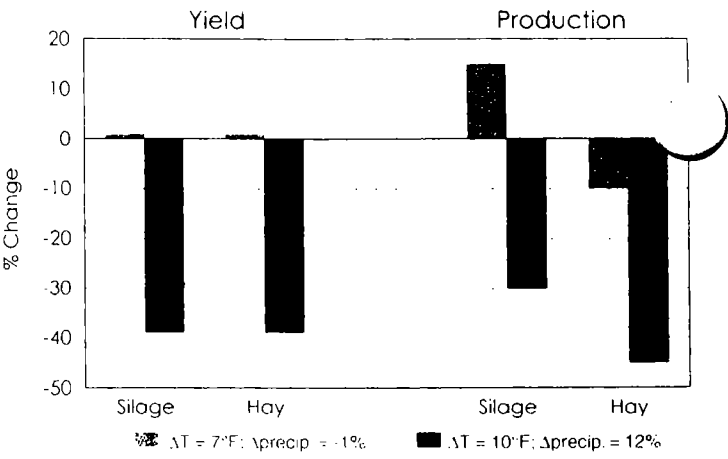
Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

In Connecticut, agriculture is a \$500 million annual industry. About one-twentieth of 1% of total U.S. farm acres is in the state. The principal crops are silage and hay, and very little of the agricultural land is irrigated. Projections of changes in Connecticut yields are mixed; they could range from little change to decreases of almost 40%. Total acres farmed would remain about the same, but farm income could decrease by about 50%.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to these conditions, such as oaks and redwoods, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Connecticut could change little. However, a warmer climate could change the character of Connecticut's forests. Maple-dominated hardwood forests could give way to forests dominated by oaks and conifers, species more tolerant of higher temperatures. This change would diminish the brilliant autumn foliage as the contribution of maples declines. Across the state, as much as 30-60% of the hardwood forests could be replaced by warmer climate forests with a mix of pines and hardwoods.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.



\$349 million will be saved by New Jersey companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.

More ENERGY STAR Facts

- New Jersey is home to 196 companies and public entities participating in ENERGY STAR partnerships.
- Over 281 million square feet of New Jersey building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 1450 times the size of the Continental Arena.
- 26 ENERGY STAR-Labeled Product manufacturers are located in New Jersey.
- Investments already made through the ENERGY STAR program in New Jersey will prevent 9 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 1 million acres of trees — an area 2500 times the size of Princeton University.
- Nitrogen oxide (NO_x) emissions will be reduced by 17 million pounds and sulfur dioxide (SO₂) by 32 million pounds due to existing ENERGY STAR investments in New Jersey.

Highlights

- Mercer County received the ENERGY STAR Buildings Government Award and Connecticut Power Delivery received the ENERGY STAR Homes Utility of the Year Award in 1999.
- Ricoh Corporation received the ENERGY STAR Labeling Imaging Partner of the Year Award in 1999 and 1998 and the Office Equipment Partner of the Year in 1996.
- Panasonic Communications & Systems Co. and Sony Electronics received the ENERGY STAR Labeling Home Electronics Partners of the Year Awards in 1999.
- Samsung Electronics received the ENERGY STAR Labeling Monitor Partner of the Year Award in 1998 and 1996.
- Johnson & Johnson received the Green Lights Large Corporate Partner of the Year Award in 1995.
- Philips Lighting Company received the Green Lights Lighting Manufacturer Ally of the Year Award in 1996 and Whitaker Newsletters received the Green Lights Small Business Partner of the Year Award in 1995.

Market Potential

- New Jersey has over 2.3 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$973 million would be saved annually
 - The following emissions would be prevented each year:
 - 21 billion pounds of CO₂
 - 35 million pounds of NO_x
 - 83 million pounds of SO₂

NEW JERSEY

ENERGY STAR Participants in New Jersey

A-Valey Engineers
 Great Atlantic & Pacific Tea Company
 Advanced Lighting Applications
 Allied Facility Services, Inc.
 AlliedSignal, Amphous Metal
 Alternating Energy Technology
 American Lighting Corporation
 American Littoral Society
 American Standard Inc
 Amerlux, Inc.
 Ames Rubber Corporation
 AnaDigital Corporation
 Apex Training Company, Inc.
 Area Lighting Research, Inc.
 Aromatic Corporation
 Artistic Lighting
 Astral
 Atlantic City Medical Center
 Atlantic Community College at Mays Landing
 Atlantic Electric
 Atlantic Lighting and Supply Co. (NJ)
 Automatic Data Processing Inc
 Bacharach Rehabilitation Hospital
 Bayonne Hospital
 Becton Dickinson and Company
 Bed Bath & Beyond
 Bell Communications Research
 Bella Rosa Pizza & Pasta Restaurant
 Bennardi and Associates
 Boswell Engineering
 Broadway Lighting Services
 CIC Supply
 Cardolite Corporation
 Casino Association of New Jersey
 Castlton Environmental Contractors
 Cherry Hill Board of Education
 Clean Ocean Action
 Community Medical Center
 Conectiv Power Delivery
 Cooper Electric Supply Company
 D and D Auto Body
 Daewoo Electronics Corp. of America
 Law Offices of David W. Boyer, P.C.
 Dock Resins Corporation
 Dolco Packaging Corporation
 Doolan Recovery Technologies
 Duro-Test Corporation
 EIZO Nanao Technologies
 EM Electric Corporation
 ESTI Energy Services Corporation
 Edison Power Technologies
 Energy & Environmental Lighting Services
 Energy Enterprise Incorporated
 The Energy Group
 Energy IQ Systems, Inc.
 Energy Kinetics
 Enterprise Property Management, Inc.
 Facility Management Consultants
 First Union
 Flexlite
 Florentine Gardens
 Funai Corporation, Inc.
 G. P. M. Inc.
 GEC Lighting Supply
 GEC Marconi Electronics Systems Corp
 GPU Energy
 GPU Service Corporation
 The Genlyte Group
 Glowmastr
 Goldstar Electronic Ballasts
 Good Friend Electric
 GreenTech Energy Services, Inc.
 Growth Restaurants
 Hackensack Medical Center
 Henderson Aquatics
 Hitachi America, Ltd.
 Hoechst Celanese
 Hoffmann-La Roche Inc.
 Homasote Company
 The Homasote Company
 Huls America Incorporated
 Hutt Lumber
 Innrange Technologies Corp
 IceCap Industries, Inc.
 Inn America Hospitality, Inc.
 Institute of Electrical and Electronic Engineers
 JVC Americas Corp
 JVC Industrial America, Inc.
 Jersey Shore Medical Center
 Johnson & Johnson
 Just Cats Veterinary Clinic, P. C.
 Kingtec, Inc.
 Kyocera Electronics, Inc.
 Lakewood Medi-Center
 Lighthouse Putt and Bat
 Lowy's Express
 ME Energy Resources
 MaGrann Associates
 Mannington Mills, Incorporated
 Mark Lighting Fixture Company
 Matsushita Electric Corporation of America
 Matsushita Home and Commercial Products Co
 Maxlight SK America, Inc.
 Megalite Corporation, Inc.
 Mercer County, New Jersey
 Merck & Company - World Headquarters
 Midlantic Bank, N.A.
 Minolta Corporation
 Mira Lighting & Electric Service, Inc
 Monitor Products Incorporated
 Montclair State University
 Morristown Memorial Hospital
 National Cathode Corporation
 National Lighting Company, Inc.
 New Jersey Business & Industry Association
 New Jersey Hospital Association
 New Jersey Transit
 The State of New Jersey
 New Marine Company L.P.
 Newark Board of Education
 Norbert Belfer Lighting
 North Jersey District Water Supply Commission
 Northwest Covenant Medical Center
 Novartis A G
 OK Electric Supply Company
 Onsite SYCOM Energy Corporation
 Ocean County College
 The Ocean County Utilities Authority
 Okidata
 Omega Institute
 PSEG Energy Technologies
 Panasonic Communications & Systems
 Panasonic Consumer Electronics Company
 Pathmark Stores, Inc.
 Philips Lighting Co.
 Precision Multiple Controls Inc. and Lumatrol
 Princeton University
 Prudential Insurance Company of America, Inc.
 Public Service Electric and Gas Company
 RAB Electric Manufacturing Company
 Reddi Form Incorporated
 Reflections, Inc.
 Remington Insurance Company
 Renaissance Towers Condominium Association
 Newark
 Rhodia Inc.
 The Richard Stockton College of New Jersey
 Ricoh Corporation
 Rivervale Township of New Jersey
 Riviana Foods Incorporated
 Robert Wood Johnson University Hospital
 RoyalLite Manufacturing & Supply Corp.
 Rutgers University
 SK America, Inc.
 Swisco
 Saint Peter's College at Jersey City
 Salem Community College at Carneys Point
 Samsung Electronics America, Inc.
 Sea Gull Lighting Products Incorporated
 Sealed Air Corporation
 Sharlin-Lite
 Sharp Electronics Corporation
 Somerset Hills Hotel
 Sony Electronics Inc.
 South Jersey Hospital, Bridgeton
 South Jersey Medical Center
 Spring Creek Properties
 St. Nicholas, Inc
 Stafford Township Board Of Education
 Star Micronics America
 Subway #12229, Ramsey, NJ
 Subway #12299 Union, NJ
 Subway #12424, Bergenfield, NJ
 Tetcom Inc.
 Terra Solar USA, Incorporated
 Toshiba America Consumer Products, Inc.
 Triumph Brewing Company
 Trump Plaza Associates
 The Trump Taj Mahal
 New Jersey Army National Guard
 Ultra Additive Inc.
 Union Camp Corporation
 United Electrical Maintenance Corp
 United Garden State Restaurant & Lodging Assn
 United Water New Jersey Inc.
 The Valley Hospital
 Volvo Cars of North America
 Voorhees Pediatric Facility
 Warner-Lambert
 Warwick Condominium Association Incorporated
 Wellspring at Aurora General Partnership
 West Jersey Health System Inc.
 Westcott Nut-Products
 Whitaker Newsletters, Inc.
 Winslow Township School District
 Zumtobel Lighting

Examples of New Jersey Partners Saving Money and Helping the Environment

Merck & Company, White House Station

- Saving \$140,000 in annual energy costs
- Reducing energy use by 1.6 million kWh annually
- Preventing 2.7 million pounds of CO₂ annually
- Features a display in its entranceway to show visitors and employees how it saves energy while preserving the building's aesthetic appeal

Sony, Park Ridge

"Sony believes that it makes sense to initiate voluntary programs between government and industry that provide benefits to consumers, manufacturers, and the environment."

— Company publication

- Saving \$2 million in annual energy costs
- Upgraded lighting in 9.5 million sq. ft. (95%)
- Reducing energy use by 22 million kWh annually
- Preventing 35 million pounds of CO₂



Cherry Hill Board of Education

"We reaped enormous financial and public relations benefits from our participation in Green Lights. We saved a lot of money and the community and students appreciated the difference we made in the environment."

— J.A. Keleher, Director of Capital Outlay Projects

- Saving \$350,000 in annual energy costs
- Upgraded lighting, exit signs, and other technologies in all schools
- Reducing energy use by 3 million kWh annually
- Preventing 4.1 million pounds of CO₂ annually

Robert Wood Johnson University Hospital, New Brunswick

- Saving \$175,000 in annual energy costs
- Reducing energy use by 3.1 million kWh annually
- Preventing 5.3 million pounds of CO₂ annually
- Able to put more funds toward better equipment and training

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And New Jersey

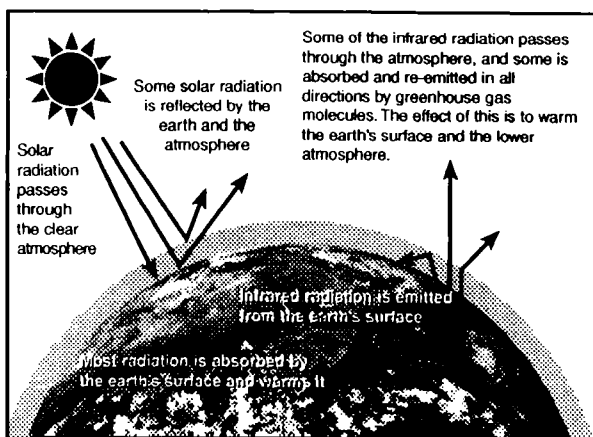
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is **enhanced** by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

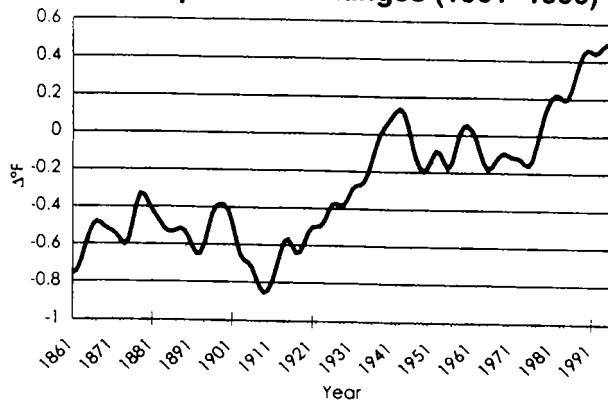
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F since the late 19th century. The 9 warmest years in this century all have occurred in the last 14 years.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen 4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere's heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. Scientists are reasonably confident about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in Brunswick, New Jersey, has increased from 50.4°F (1889-1918 average) to 52.2°F (1966-1995 average), and precipitation in some locations in the state has increased by 5-10%.

Over the next century, New Jersey's climate may change even more. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in New Jersey could increase about 4°F (with a range of 2-8°F) in winter and spring, and slightly more in summer and fall, if greenhouse-gas emissions are not controlled. Precipitation is projected to increase by 10-20% (with a range of 0-40%), with slightly less change in spring and slightly more in winter.

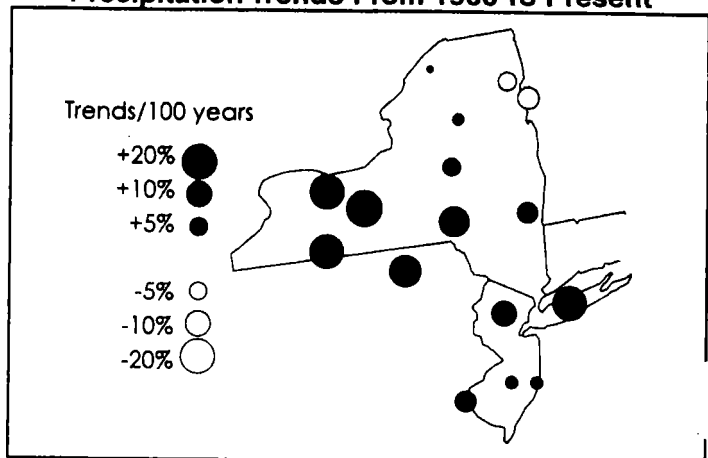
The amount of precipitation on extreme wet (or snowy) days most likely would increase, but changes in the lengths of wet or dry spells are not clear. The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms such as hurricanes would change.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. New Jersey, with its irregular, intense heat waves, seems very susceptible.

In Newark, one study projects that a 2-3°F warming could increase heat-related deaths during a typical summer fivefold, from about 25 today to near 125 (although increased air conditioning use may not have been fully accounted for). Decreases in winter mortality probably would be less than the summer mortality increases if the climate warms. The elderly, particularly those living alone, are at greatest risk.

There is concern that climate change could increase ozone levels. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Furthermore, air pollution also is made worse because natural hydrocarbons emissions increase during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

A 4°F warming in New York City, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by 4%. Similar increases also could occur in New Jersey. Current ozone concentrations exceed the national health standards for ozone throughout the state. Virtually all of New Jersey is classified as an "extreme and severe" nonattainment area for ozone. Ground-level ozone has been shown to aggravate existing respiratory illnesses such as asthma, reduce lung function, and induce respiratory inflammation. In addition, ambient ozone reduces agricultural crop yields and impairs ecosystem health.

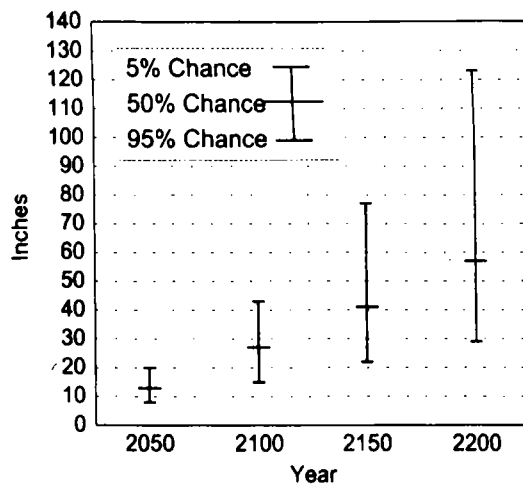
Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitos flourish in some areas around New Jersey. Some can carry malaria, while others can carry Eastern equine encephalitis, which can be lethal or cause neurological damage. Lyme disease, which is carried by ticks, has increased in the Northeast. If conditions become warmer and wetter, mosquito and tick populations could increase, thereby increasing the risk of transmission of these diseases.

In addition, warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. These blooms can damage habitat and shellfish nurseries, can be toxic to humans, and can carry bacteria like those causing cholera. Brown algal tides and toxic algal blooms already are prevalent in the Atlantic. Warmer ocean waters could increase their occurrence and persistence.

Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads,

Future Sea Level Rise At Atlantic City



Source: EPA (1995)

causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

Along much of New Jersey's coast, sea level already is rising by 15 inches per century, and it is likely to rise another 27 inches by 2100. A large portion of New Jersey's 130-mile coastline is vulnerable to extensive erosion and flooding from sea level rise and storms. The New Jersey coastline is made up primarily of long narrow barrier islands, low-lying salt marshes, and tidal flats. Because of this topography, sea level rise could inflict extensive damage on New Jersey's valuable, high-density coastal real estate and recreational beaches. Rising seas also would inundate many acres of New Jersey's remaining coastal salt marshes and tidal flats that provide flood protection, water quality benefits, and habitat for native species, as marsh plants die or recede to higher elevations.

Protecting New Jersey's coast would require significant resources and planning. For example, estimates of the cost of protecting Long Beach Island with seawalls and more sand from a 1-3 foot increase in sea level over the next century are \$100-\$500 million. These costs could begin to accrue soon and continue to be incurred throughout the next century.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation from streams and lakes is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

Ensuring the supply of high quality municipal and industrial water is the most critical water resource issue in New Jersey. About half the state's potable water comes from streams and rivers, primarily the Delaware, Raritan, and Passaic rivers, and numerous small streams. The other half comes from groundwater. Except

for that part of the Delaware River that flows from upper New York State, winter snow accumulation has only a modest effect on New Jersey streams. However, streamflow could decrease because of the increased evaporation that would accompany warmer temperatures. The mean annual flow of the Delaware River at Trenton could decrease about 15% if average temperatures warm 4.5°F and precipitation remains unchanged. Urbanization has lowered water quality and increased flooding in many small New Jersey rivers and streams, especially in the northern part of the state. Reduced flows, especially in summer, would exacerbate the decline in water quality. Many New Jersey aquifers also have been contaminated because of industrial and urban development. In the absence of increased precipitation, the amount of ground-water available to refill the aquifers could decrease.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

In New Jersey, agriculture is about a \$0.7 billion annual industry, two-thirds of which comes from crops. About 6% of New Jersey's agricultural land is irrigated. The principal crops are hay, corn, soybeans, and some vegetables. Projections of changes in

New Jersey yield are mixed; they could range from up by 25% to down by 38%. Climate change could lower total acres farmed and production, as well as farm income.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to warmer conditions, such as southern pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent and density of forested areas in New Jersey could change little or could decline by as much as 10-20%. However, wildfire frequency almost certainly would change with hotter and drier conditions. The types of trees dominating New Jersey forests are likely to change. The mixed forests, dominated by southern pines and oaks, would spread northward throughout the state. These forests would replace the predominantly hardwood forests currently found in the northern half of the state.

Ecosystems

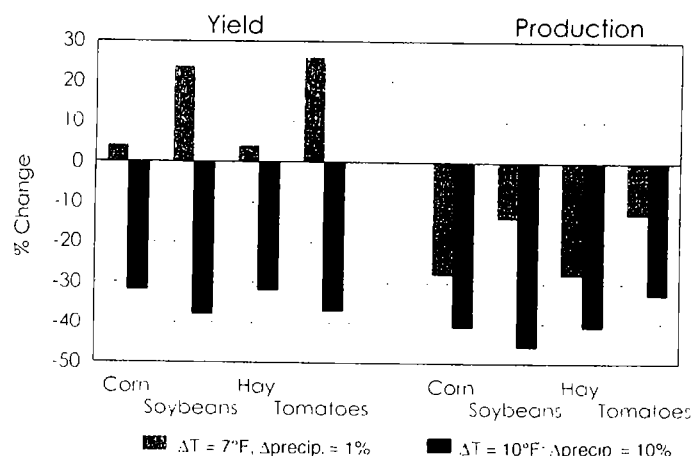
The most important ecosystems of New Jersey that would be vulnerable to climate change are the coastal wetlands and the forested Pine Barrens. The Pine Barrens cover approximately 1 million acres of the Outer Coastal Plain in southern and central New Jersey. The Pine Barrens provide the habitat for rare and unusual species, including the pine barrens treefrog, which is protected by the Endangered Species Act. Because there are few natural corridors that would allow migration of species, their ability to adapt and migrate in response to climate change could be limited.

Plant and animal species near the borders of their ranges are likely to be most affected by climate change. Species better adapted for cool conditions would need to migrate northward, while southern species of plants and animals (including noxious weeds such as kudzu and insect pests such as fire ants) could spread into the state.

New Jersey's coastal wetlands are among the largest and most diverse in the mid-Atlantic region. Sea level rise would alter flooding and salinity, with substantial impacts on wildlife and fisheries. Losses of tidal freshwater wetlands would be especially harmful to foraging grounds for wading birds.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

CCAP NEWS RELEASE



**Governor Tony Earl
Quarles & Brady
Chair**

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Executive Director**

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For Immediate Release: Contact: Ned Helme or Sue Gander 202/408-9260

NEW JERSEY AND THE NETHERLANDS INITIATE HISTORIC JOINT EFFORT ON CLIMATE CHANGE

Center for Clean Air Policy to Coordinate International Emissions Trade

Trenton, NJ, June 5, 1998 -- "This pathbreaking agreement signifies a tremendous opportunity for New Jersey to advance its understanding of global climate change and represents an important first step towards international trading in early reductions of CO₂," proclaimed Ned Helme, Executive Director of the Center for Clean Air Policy.

At a signing ceremony at the New Jersey State House, the Dutch government and the state of New Jersey entered into a first-of-its kind letter of intent to cooperate in addressing the challenges posed by climate change, including efforts to identify and design a prototype greenhouse gas emissions trade. Signatories were Margaretha de Boer, Minister of Housing, Spatial Planning and the Environment of the Netherlands and Robert C. Shinn, Commissioner of the New Jersey Department of Environmental Protection along with Ned Helme, as official witness.

The Center's director outlined how emissions trading offers a cost-effective way to meet the commitments agreed to in the Kyoto Protocol. "Trades established in advance of the 2008 to 2012 Kyoto budget period will help prove that we can have a workable trading system for greenhouse gases. Moreover, it will start companies on the path to the needed reductions and cut the cost of meeting our climate change goals," he explained.

A greenhouse gas early reduction program establishes a mechanism for recognizing and awarding "credit" to sources that make reductions in advance of mandatory requirements, thereby providing incentives to achieve early reductions in emissions. These credits could either be used to meet commitments (e.g., under the Kyoto Protocol) or sold to other participants. Several countries are considering such a program as a means of easing the transition to a mandatory program. The Center laid out a plan for how to extend this concept to the international level.

The Center is working with New Jersey Department of Environmental Protection (NJDEP) to develop an emissions bank for early reduction credits -- to acknowledge actions taken in advance of a mandatory program and help New Jersey companies meet the target of a 3.5 percent reduction below 1990 levels by 2005 set forth in a recent NJDEP administrative order. "Today's action is just the latest example of the leadership New Jersey and the Netherlands have demonstrated on the issue of climate change," Helme noted.

"An interesting twist to the plans for a New Jersey-Dutch trade is that the Netherlands may be purchasing credits generated by New Jersey companies," said Helme, "whereas most people assume that U.S. companies will be the buyers of emissions credits, such a trade shows the possibilities of trading in both directions."

Through purchasing the emissions credit generated by a reduction at a New Jersey source, the Netherlands would, in effect, be financing the reduction effort. Not only would the New Jersey company enjoy an economic benefit, but, if the greenhouse gas emissions reduction was associated with multiple pollutant decreases -- for instance, under a fuel switch from coal to natural gas which would cut NO_x, SO₂ and mercury as well as CO₂ -- New Jersey citizens would enjoy the benefit of improved air quality as well as reduced risk of climate change.

The Kyoto Protocol, an international agreement to address climate change through the reduction of greenhouse gases, was agreed to by over 150 countries following a two-week negotiation in Kyoto, Japan in December, 1997. The Protocol includes an overall greenhouse gas emissions target of 5.2% below 1990 levels by 2008-2012 for Annex I (developed) countries -- with each country adopting targets between 10% above and 8% below 1990. The US target is a 7% reduction, which, by 2010, could entail a 30 to 40% cut from "business as usual".

"Two densely populated, highly industrialized, coastal regions, New Jersey and the Netherlands share a common concern with the sea level rise impacts associated with global climate change," stated Helme, "as such, they both recognize the importance of sustainable economic growth." "This new partnership will help identify opportunities for cost-effective solutions," he stressed.

Recent scientific assessment of the impacts of climate change have predicted increases in worldwide sea levels of up to 1 meter in the next century. The impact for New Jersey is expected to be greater than average, with major implications such as increased shoreline displacement, loss of wetlands, and potential inundation of barrier islands. Climate change is also associated with changes in growing seasons, shifting vegetation patterns, changing weather patterns and increased spread of diseases -- effects that have a number of related economic and social implications such as loss of agricultural crops, declining tourism and public health threats.

The Center has pioneered demonstrations of low-cost CO₂ reductions overseas through projects known as "joint implementation" or JI. "For example, our Decin project in the Czech Republic -- the first JI project of its kind in the world -- is a joint energy project between three US utilities and a Czech city to convert a local heating plant from dirty coal to clean natural gas. It is a 'win-win' situation where the city will project its heat and electricity in a cleaner environmental, and the US companies will receive credit from the associated CO₂ reductions," explained Helme.

The Center for Clean Air Policy is a Washington, DC-based think-tank that seeks cost-effective solutions to domestic and international energy and environmental problems. Founded by a group of progressive state governors in 1985, the Center played a key role in the development of the SO₂ trading

program to help control acid rain. The Center advocates emissions reductions domestically and internationally through trading programs and other market-based approaches to clean air.

###

- 1) Six greenhouse gases are covered: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

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\$21 million will be saved by Montana companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



More ENERGY STAR Facts

- Montana is home to 14 companies and public entities participating in ENERGY STAR partnerships.
- Over 20 million square feet of Montana building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 100 times the size of the State Capitol.
- 1 ENERGY STAR-Labeled Product manufacturer is located in Montana.
- Investments already made through the ENERGY STAR program in Montana will prevent 558 million pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 76,000 acres of trees — an area 380 times the size of the University of Montana.
- Nitrogen oxide (NO_x) emissions will be reduced by 1.4 million pounds and sulfur dioxide (SO₂) by 1.2 million pounds due to existing ENERGY STAR investments in Montana.

Highlight

- Halliburton Company received the Green Lights Corporation Partner of the Year in 1996.

Market Potential

- Montana has 260 million square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$19 million would be saved annually
 - The following emissions would be prevented each year:
 - 1 billion pounds of CO₂
 - 5 million pounds of NO_x
 - 5 million pounds of SO₂

MONTANA

ENERGY STAR Participants in Montana



Bigfork School District 38
Blue Body & Paint
Corbond Corporation
Dalton Ace Hardware
Ironwood Mfg
Kalispell Hospital
Montana Hospital Association
State of Montana
Rome Specialty Company
Subway #7860, Laurel, MT
Malmstrom Air Force Base
Montana Army National Guard
The Washington Group
West-Tech Supply

Examples of Montana Partners Saving Money and Helping the Environment

Halliburton Company, Havre

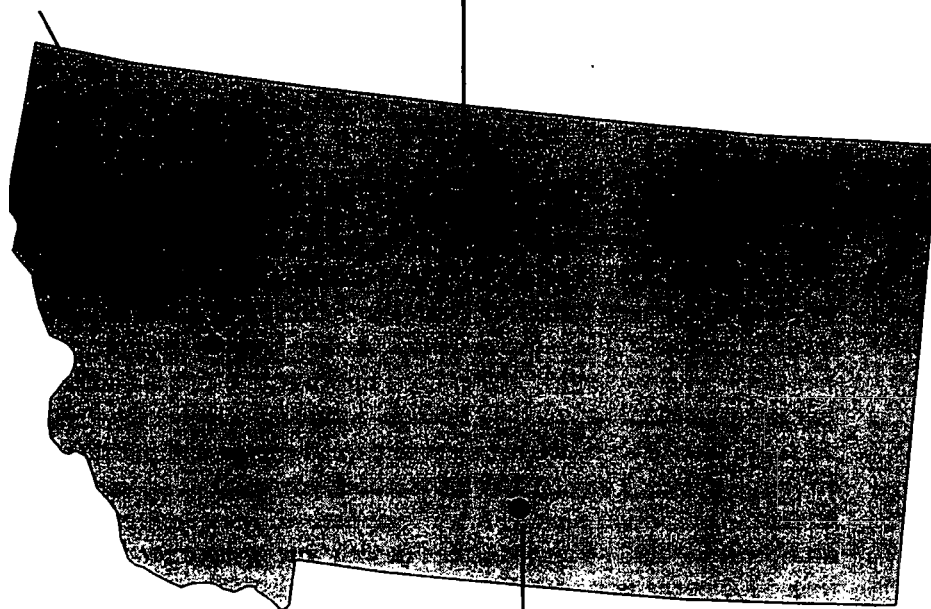
"[Green Lights] looked like a good deal. It made sense, so we jumped in with both feet."

— Richard Laxen, Project Manager

Albertson's, Inc., Helena

- Saving \$51,000 in annual energy costs
- Upgraded lighting for 117,000 sq. ft.
- Preventing 1.6 million pounds of CO₂ annually
- Upgraded one third of its 36 million sq. ft. of stores nationwide

- Saving \$3,000 in annual energy costs
- Reducing energy use by 50%
- Preventing 88,000 pounds of CO₂ annually
- Company's mission is to upgrade all of its 8.2 million sq. ft. with energy-efficient technologies



State of Montana

- Saving \$722,000 in annual energy costs
- Upgraded 20% of its square footage
- Reducing energy use by 10 million kWh annually
- Preventing 16 million pounds of CO₂ annually

W.W. Grainger, Inc., Billings

"Green Lights makes sense because it not only reduces operating expenses, but it also helps keep the environment safe for current and future generations."

— Ted Cowen, Director of Field Services

- Saving \$5,500 in annual energy costs
- Completed lighting upgrades for 21,600 sq. ft.
- Reducing energy use by 50%
- Preventing 82,000 pounds of CO₂ annually
- Company has completed lighting upgrades to all of its 6.8 million sq. ft. for an annual cost savings of \$3.9 million

EPA's ENERGY STAR Programs

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Climate Change And Montana

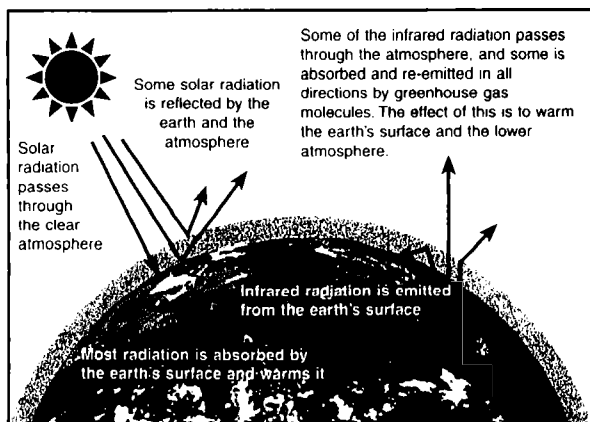
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The Climate System

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The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, common air pollutants, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally.

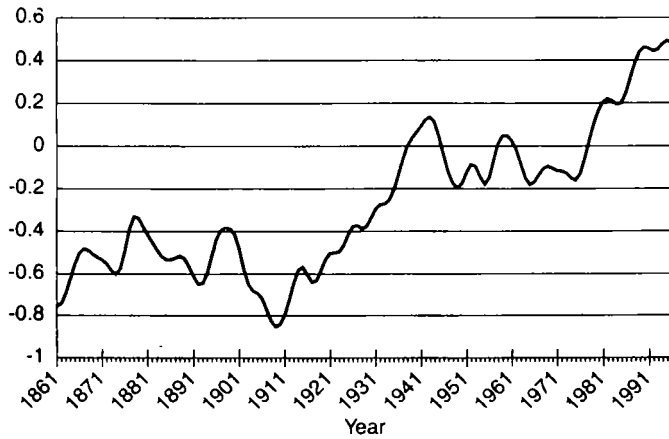
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Current Climatic Changes

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Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



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1-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

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For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

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Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

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well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

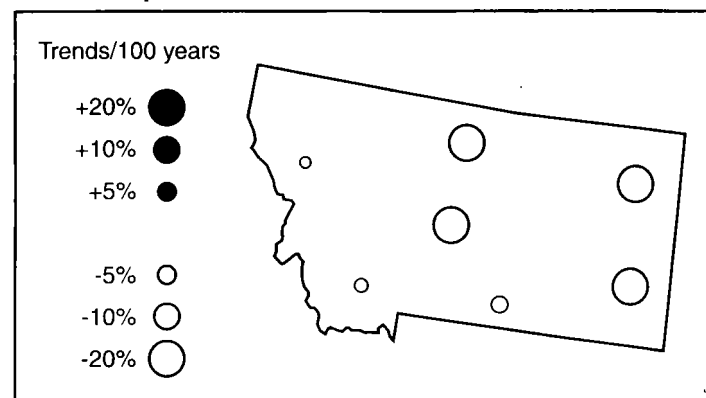
Over the last century, the average temperature in Helena, Montana, has increased 1.3°F, and precipitation has decreased by up to 20% in many parts of the state.

Over the next century, climate in Montana may change even more. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Montana could increase by about 4°F in spring and summer (with a range of 1-8°F) and 5°F in fall and winter (with a range of 2-10°F). Precipitation is estimated to increase by roughly 10% in all seasons except winter, when the range of estimated increase is 15-40%. The amount of precipitation on extreme wet or snowy days in winter is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. Although it is not clear how severe storms would change, an increase in the frequency and intensity of winter storms is possible.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Montana, with its irregular, intense heat waves, could be susceptible. The elderly, particularly those living alone, are at greatest risk.

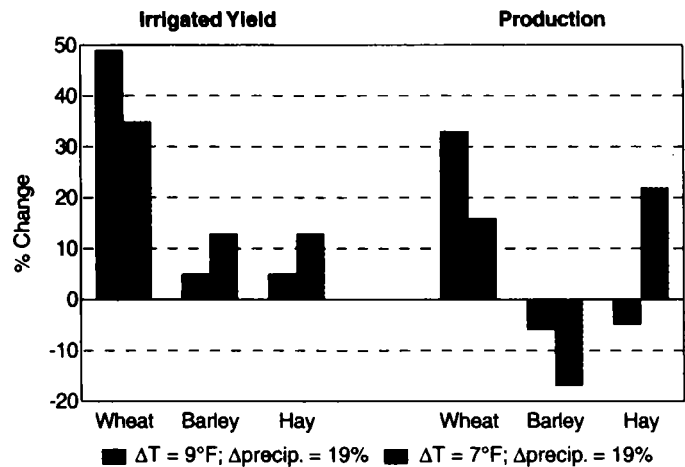
Warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases. A recent study has concluded that a 5-9°F temperature increase would cause a significant northern shift in Western equine encephalitis outbreaks. Mosquitos capable of transmitting this disease already are present in Montana. If Montana's climate becomes warmer and wetter, mosquito populations could increase and conditions may become more favorable for disease transmission.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. If streamflow and lake levels drop, groundwater also could be reduced. In addition, more intense precipitation could increase flooding.

Western Montana drains into the Columbia River system, and most of the remaining areas of the state drain to the east into the Missouri River or its major tributary, the Yellowstone River. Winter snow accumulation and spring melt are key processes that affect the runoff of all rivers within the state. A warmer climate would lead to earlier spring snowmelt, resulting in higher streamflows in winter and spring and lower streamflows in summer and fall. Earlier spring snowmelt could reduce the performance of the reservoir system in western Montana, thus reducing summer and fall runoff, which is critical for power generation, fisheries protection, recreation, and other uses. Increased rainfall could mitigate some of these effects, but it also could lead to increased flooding.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

In Montana, agriculture is a \$1.8 billion annual industry, one-half of which comes from livestock, mainly cattle. Just over 20% of the crop acreage is irrigated. The major crops in the state are wheat, barley, and hay. In a warmer climate wheat yields could increase by more than a third, and changes in barley and hay yields could vary between -8% and +13%, depending on whether irrigation is used, leading to changes in acres farmed and production. For example, barley yields could rise while production falls because of a decrease in barley acres farmed. An increased dependence on irrigation is possible, depending on the relative balance between rainfall and increased evaporation.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic range, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to these conditions, such as fir and spruce, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Montana may change little or could decline by as much as 15-30%. The uncertainties depend on many factors, including whether soils become drier and, if so, how much drier. Hotter, drier weather could increase the frequency and intensity of wildfires, threatening both property and forests. Drier conditions could reduce the range and health of lodgepole and Douglas fir forests, and increase their susceptibility to fire. With increases in rainfall, however, these effects could be less severe. Grass and range-land could expand into previously forested areas along the eastern slope of the Rocky Mountains and into some of the western valleys. Milder winters could increase the likelihood of insect outbreaks and of subsequent wildfires in the dead fuel left after such an outbreak. These changes would significantly affect the character of Montana forests and the activities that depend on them.

Ecosystems

Ecosystems in Montana are diverse, ranging from grasslands and deserts to mountain shrublands, forests, meadows, and alpine tundra. They also include numerous wetlands and streams. Because of elevation changes and human land use, many habitats are fragmented and restricted in area. Changes in temperature and precipitation caused by climate change could affect the location and productivity of these ecosystems.

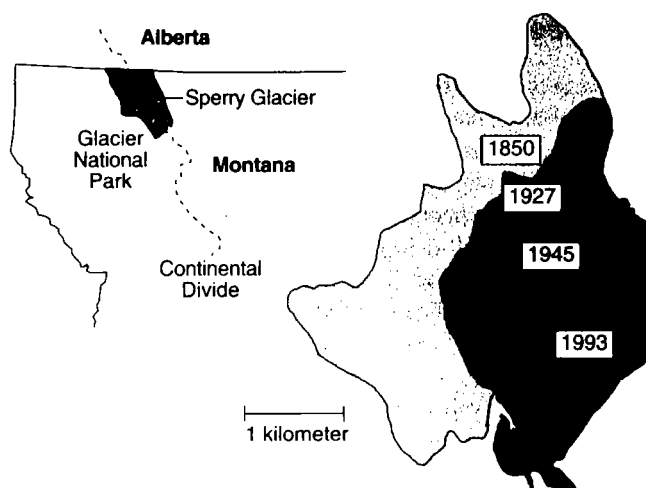
Warming and changes in precipitation could affect alpine areas, causing tree lines to rise by roughly 350 feet for every degree Fahrenheit of warming. Mountain ecosystems such as those found in Glacier National Park could shift upslope, reducing habitat for many subalpine species. Alpine animals and species, many of which are unique to the region, could disappear from the highest elevations. Mountain glaciers such as those found in Glacier National Park are expected to shrink, possibly leading to higher stream temperatures and decreased runoff. This would adversely affect aquatic biota, including trout species. Changes in rainfall and snowfall also could alter streamflows and wetlands, affecting wildlife and possibly accelerating the invasion of non-native plants into streamside habitats. Aquatic species that are sensitive to water temperature could be affected adversely by climate change. Brown trout and rainbow trout could lose habitat.

Glacier National Park

Glacier National Park is located in a pristine mountainous area in northwest Montana. The park provides habitat for an abundance of wildlife, including the most dense population of grizzly bears (an endangered species) in the United States. Other endangered animal species found in the park include the bald eagle and the gray wolf. Over 1,400 different plants live in Glacier Park, 28 of which are found nowhere else in Montana.

Climate change could have a serious impact on Glacier National Park. The park has approximately 50 glaciers today, down from an estimated 150 glaciers in 1850. The recession of Sperry Glacier illustrates the impact of recent warming temperatures in the park. If these warming trends continue, it is estimated that no glaciers will be found in the park by 2030. Without glaciers, stream temperatures are expected to rise, which could affect aquatic ecosystems in the park, including trout species. Climate change also could affect the types of trees found in the forests. Lodgepole pine and western cedar forests could yield to forests dominated by spruce and western hemlock. Six rare alpine plants that are at the southern border of their geographic range would be especially vulnerable to climate change.

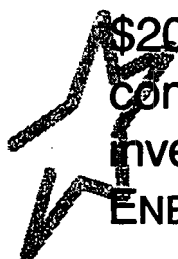
Sperry Glacier Recession 1850-1993



Source: USGS Biological Resources Division, Glacier Field Station. Carl H. Key, provisional data (1997)

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.





\$204 million will be saved by Washington companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



More ENERGY STAR Facts

- Washington is home to 80 companies and public entities participating in ENERGY STAR partnerships.
- Over 171 million square feet of Washington building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 610 times the size of the Kingdome.
- 2 ENERGY STAR-Labeled Product manufacturers are located in Washington.
- Investments already made through the ENERGY STAR program in Washington will prevent 4.8 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 660,000 acres of trees — an area more than 950 times the size of the University of Washington.
- Nitrogen oxide (NO_x) emissions will be reduced by 2 million pounds and sulfur dioxide (SO₂) by 5 million pounds due to existing ENERGY STAR investments in Washington.

Highlights

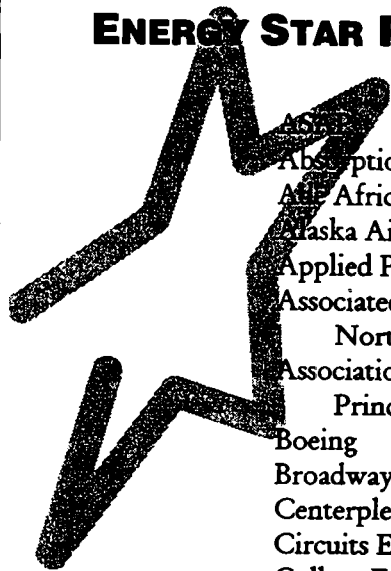
- Boeing received the Green Lights Corporate Partner of the Year Award in 1999.
- Larry's Markets received the Green Lights Small Corporation Partner of the Year Award in 1996.

Market Potential

- Washington has 1.6 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$287 million would be saved annually
 - The following emissions would be prevented each year:
 - 8 billion pounds of CO₂
 - 3.7 million pounds of NO_x
 - 6.8 million pounds of SO₂

WASHINGTON

ENERGY STAR Participants in Washington



Absorption Corporation
 ALE Africana
 Alaska Air Group Inc
 Applied Process Engineering Laboratory
 Associated Industries of the Inland
 Northwest
 Association of Washington School
 Principals
 Boeing
 Broadway Group
 Centerplex, Seattle
 Circuits Engineering, Inc
 College Fund
 Costco Companies, Inc.
 ESSCO Electric, Inc.
 Electric Ideas Clearinghouse
 Empire Bolt & Screw
 Entek Corporation
 Geosafe Corp
 Graham Road Recycling & Disposal
 Facility, Inc.
 Grant County Public Utility District
 Grays Harbor County PUD #1
 Greater Seattle Chamber of Commerce
 Harborview Medical Center
 Horizon Air Industries, Inc.
 ICM Asset Management, Inc.
 Inland Technology, Inc.
 Kettle Range Conservation Group
 King County, Washington
 Larry's Markets, Incorporated
 Lighting Design Lab
 Lite Tech International
 Lon Gibby Productions Inc.
 ML Park Place Corporation
 Mason County Public Utility District
 (PUD) No. 3
 McGregor Gardens
 Microsoft Corporation
 Natt
 North Coast Distributing Company
 North Coast Electric Company
 NorthstarHydro Cleaning Systems Inc.
 Northwest Air Pollution Authority
 Northwest Public Power Association
 Output Technology Corporation
 PLC-Multipoint
 Pacific Northwest National Laboratory

Pacific NW Pollution Prevention Research
 Ctr
 Pacific Northwest Ski Areas Association
 Port Angeles City Light Department
 Port of Seattle, Aviation Division
 Pourette
 Private Equity Services & Innovations
 Providence Yakima Medical Center
 Puget Sound Energy
 Sacred Heart Medical Center
 Seattle Area Hospital Council
 Seattle Public Schools
 Seattle University
 Sellen Construction
 Sisters of Providence Health System
 Skyline Spokane
 Sol Pro Inc.
 Spokane Chamber of Commerce
 Spring Environmental Inc.
 Stusser Electric Co.
 THK Corporation, DBA Sea Galley
 Tally Corporation
 The Communitas Group
 Tidyman's
 Veterans Affairs Medical Center, Seattle
 Washington Army National Guard
 Washington Assn of Maintenance & Ops
 Administrators
 Washington Association of School Admin
 Washington Association of School Business
 Officials
 Washington State Hospital Association
 Washington State School Directors
 Association
 WA State Superintendent of Public
 Instruction
 Western Cartage Inc
 Westin Hotels & Resorts
 Whatcom County, Washington
 World Vision

Examples of Washington Partners Saving Money and Helping the Environment

Boeing, Seattle

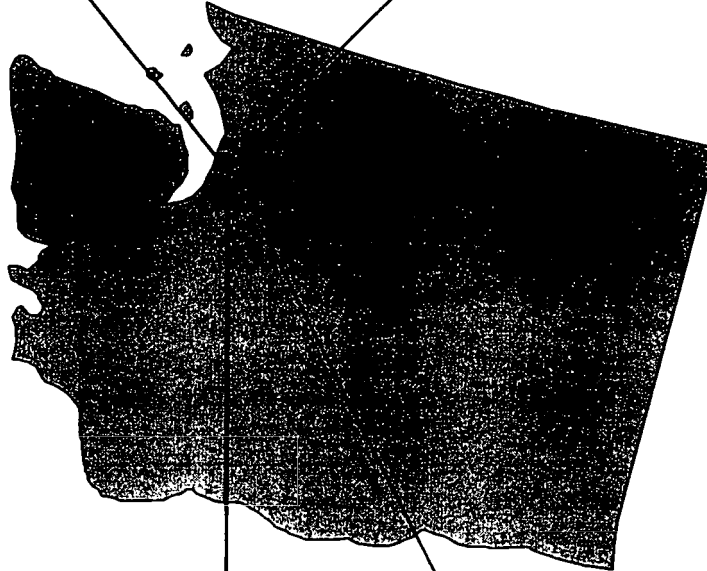
- Saving \$5 million in annual energy costs
- Upgraded lighting for 80 million sq. ft.
- Reducing energy use by 124 million kWh annually
- Preventing 91 million pounds of CO₂ annually

Westin Hotels and Resorts, Seattle

"Customer satisfaction is the name of the game in the hotel business, and our guests have given their enthusiastic approval of the upgrades."

— Gus Newberry, Manager of Engineering and Technical Services

- Saving \$545,000 in annual energy costs
- Upgraded lighting in 9.2 million sq. ft.
- Reducing energy use by 9 million kWh annually
- Preventing 14.4 million pounds of CO₂



Centerplex, Seattle

- Saving \$14,000 in annual energy costs
- Realized a 77 percent reduction in lighting energy use
- Reducing energy use by 207,500 kWh annually
- Preventing 21,000 pounds of CO₂ annually

Larry's Markets, Seattle

"Implementing upgrades and practices that cut my utility costs by 20 percent is the same as achieving a 20 percent increase in net profit."

— Brant Rogers, Director of Environmental Affairs

- Saving \$59,000 in annual energy costs
- Completed lighting upgrades for 165,000 sq. ft.
- Reducing energy use by 1.4 million kWh annually
- Preventing 890,000 pounds of CO₂ annually

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings to distinguish those buildings that demonstrate superior performance. The savings already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient products for their homes and offices by awarding the ENERGY STAR label to high-quality products. These products save money because they use less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR label on those product models that meet or exceed energy and performance standards set by EPA and DOE. The ENERGY STAR Label now appears on more than 100 energy-consuming products ranging from computers to refrigerators to air conditioners. The number of ENERGY STAR qualified models across these product categories has more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary participation by builders to construct residences that are at least 30 percent more energy efficient than current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced ventilation, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings more than exceed the small increase in monthly mortgage costs from the more energy-efficient features. The Program saves thousands of dollars over the life of a home, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and builders.



Climate Change And Washington

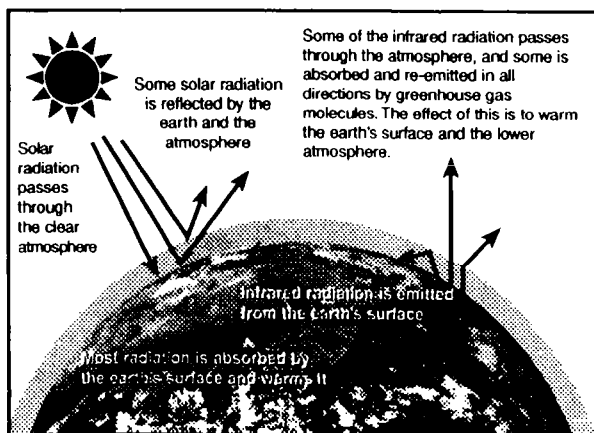
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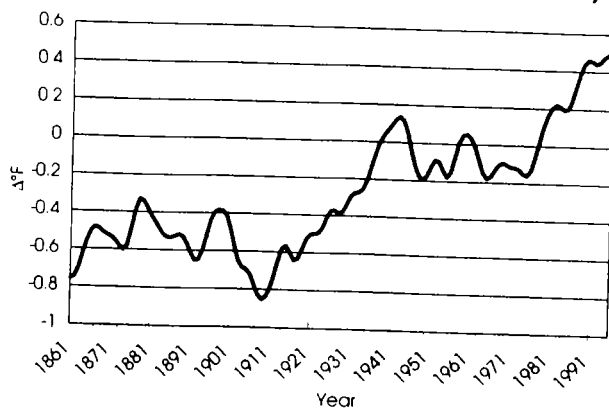
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Local Climate Changes

Over the last century, the average temperature in Ellensburg, Washington, has increased from 46.2°F (1900-1929 average) to 47.2°F (1966-1995 average), and precipitation has increased by up to 20% in some areas of the state, especially in the west.

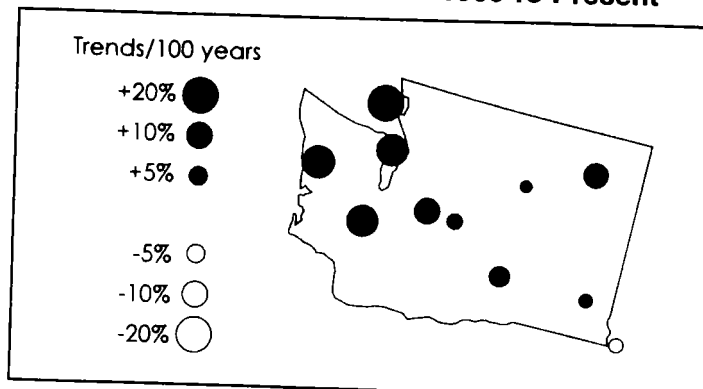
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The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms would change.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

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Source: Karl et al. (1996)

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Winter-related mortality in Washington could increase if such a warming occurs, because the frequency of air masses associated with inclement weather is expected to increase. One study has estimated that a 3°F warming in Seattle would increase winter-related mortality from 15 today to about 40. The elderly, particularly those living alone, are at greatest risk.

There is concern that climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbons emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

Increased emissions and accelerated atmospheric chemistry could slow progress being made in Washington to provide healthy and clean air. Currently, the Seattle-Tacoma area does not meet the national health standards for ozone and particulate matter. The particulate matter standard is also not met in Olympia, Spokane, Wallula, and Yakima. Ground-level ozone has been shown to aggravate existing respiratory illnesses such as asthma, reduce lung function, and induce respiratory inflammation. In addition, ambient ozone reduces agricultural crop yields and impairs ecosystem health.

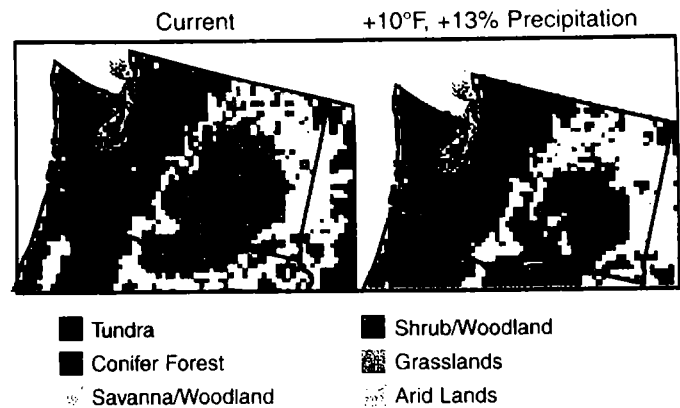
Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

At Seattle, Washington, sea level already is rising by 8 inches per century, and it is likely to rise another 19 inches by 2100. Washington's coastal region consists primarily of cliffs and a few low-lying tidal flats. The Puget Sound region contains tidal flats, river deltas with salt marshes, and swamps, as well as a heavily modified urban shoreline around Seattle. Many marshes in this region have been diked, drained, and converted to farmland during the last century. Sea level rise could gradually inundate the remaining tidal flats. Over half of these could be lost under a 1-3 foot rise in sea level.

Possible responses to sea level rise include building walls to hold back the sea, allowing the sea to advance and adapting to it, and raising the land (e.g., by replenishing beach sand and/or elevating houses and infrastructure). Each of these responses will be costly, either in out-of-pocket costs or in lost land and structures. For

Changes In Forest Cover



Source: VEMAP Participants (1995); Neilson (1995)

example, the cumulative cost of sand replenishment to protect Washington's coastline from a 20-inch sea level rise by 2100 is estimated at \$143 million to \$2.3 billion.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to these conditions, such as hemlock and sitka spruce, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Washington could change little, or they could decline by 15-25%, primarily east of the Cascades. The uncertainties depend on many factors, including whether soils become drier and, if so, by how much drier. Wildfire frequency and intensity could increase and threaten the important timber producing areas of the state. In Washington's highly productive conifer forests, drier conditions would favor an expansion of Douglas fir, lodgepole pine, and ponderosa pine forests at the expense of the wet-loving hemlock and sitka spruce along the coast. These changes could affect the character of some of Washington's forests and the activities that depend on them.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels.

particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

All of Washington to the east of the Cascade Mountains lies within the Columbia River drainage basin, where flow is dominated by spring snowmelt. The third of the state that lies to the west of the Cascades is drained by numerous smaller streams that flow to Puget Sound, the Pacific Ocean, or the lower Columbia. Those streams with headwaters at high elevations, especially in the Cascades and Olympics, are affected by winter snow and spring snowmelt, but lower elevation streams are dominated by winter rainfall. The seasonal pattern of flow in most streams in the eastern part of the state, and many in the west, would be highly susceptible to warmer temperatures. Runoff peaks would occur earlier in the year, which could cause problems for many of the state's reservoirs, which are small in comparison to their inflows and therefore might not be able to supply water with the same reliability as they do under current climatic conditions.

The reduced summer and fall flows that would accompany a warmer climate almost certainly would result in degraded water quality. In addition, increased snowmelt could increase winter flooding for some westside streams. Some eastside streams, which are now rarely affected by fall and winter flooding, also could become susceptible to winter snowmelt flooding. On the other hand, the susceptibility of eastside streams to spring snowmelt floods, which now account for most large floods in eastern Washington, most likely would decrease because of reduced spring snow accumulations.

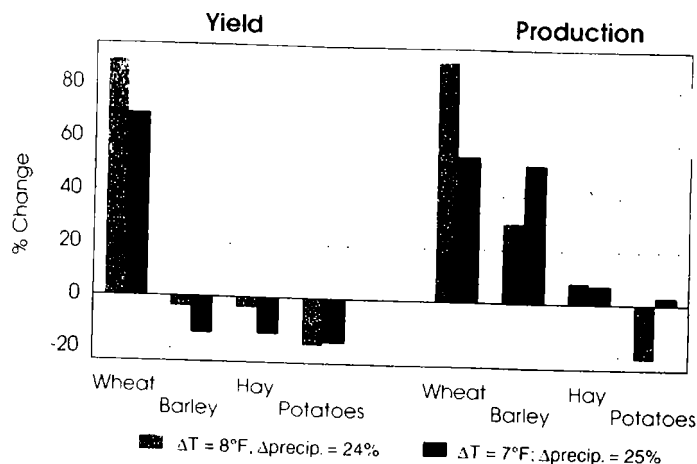
Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

In Washington, agriculture is about a \$4 billion annual industry, two-thirds of which is crops like wheat, barley, hay, and potatoes. About 28% of the state's farm acres is irrigated. With warmer

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

temperatures, wheat yields could increase by up to 70-90%. Barley and hay yields could decrease by 4-14%, and potato yields could fall by 17%. Farm income could double or triple. The number of irrigated acres could increase. This could further stress water supplies, which may already be lower in the summer, and water quality could be degraded further.

Ecosystems

The primary natural features of Washington that are vulnerable to climate change are its extensive rivers, streams, and coastal estuaries. These environments are critical for a wide diversity of wildlife, endangered species, and commercial and sport fisheries.

Reduced flows of headwater streams, or changes in their seasonal flows, could reduce the amount of suitable salmon spawning habitat. In recent years, populations of salmon and steelhead have been reduced to less than 10% of historical levels. While these past losses cannot be attributed to climate change, pink and chum salmon could lose all of their habitat with climate change. Other cold water species such as brook trout, brown trout, and mountain whitefish could lose most of their habitat. Farther downstream, increases in sea level and decreases in river flow could affect estuaries, increasing salinities and decreasing tidal marsh area. Valuable commercial shellfish communities (e.g., oysters and clams) and duck and geese populations that utilize these flats for habitat and feeding also may decline accordingly.

In addition, mountain ecosystems could shift upslope, reducing habitat for many subalpine species. At lower elevations, species now found in warmer climates may survive. For example, the climate in eastern Washington could become warm enough to support saguaro cactus.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.



Climate Change Mitigation in Washington

Washington's Greenhouse Gas Emissions (1990)¹

- Total greenhouse gas emissions in 1990 were about 19 million metric tons of carbon-equivalent, about 1% of the U.S. total for that year.
- Per capita emissions for 1990 were about 3.9 metric tons, lower than the 1990 national average of 5.3.
- The major source of greenhouse gas emissions in Washington was transportation, which accounted for about 33% of all emissions.
- The second highest source of greenhouse gas emissions in Washington was forestry products, accounting for 26% of emissions, followed by industry, which accounted for about 13% of emissions.

Mitigation Policy Planning:

- In 1996, the Washington State Energy Office completed *Greenhouse Gas Mitigation Options for Washington State*. The report identified a list of options that would reduce emissions to 1990 levels by 2010 for less than \$5 per ton reduced. The box below lists the policies recommended the report²

Policies Recommended in Washington:

Residential:

- Existing home retrofit programs (install fluorescent lighting, hot water tank upgrade, direct use of natural gas, R-19 and R-30 attic insulation, R-11 wall insulation, R-19 floor insulation, Low flow shower heads, R-11 duct insulation, caulking joints)
- New Building codes (Class 35 Windows code, R-30 floor insulation code, R-38 attic insulation code, R-21 wall insulation code)

Commercial:

- Efficiency measures relating to refrigeration (multiple compressors, glass doors for supermarket displays), lighting (Fluorescent lamps, ballasts, lighting fixtures, lighting control switches)
- Improvements for Public Buildings for lighting, heating, ventilating, air conditioning, and appliances (schools, recreation facilities, prisons)

Transportation:

- More efficient airplane engines
- Increased parking fees
- Inclusion of tire pressure check on inspection and maintenance program
- FeeBates
- Gasoline Tax (\$1.00/gallon)
- Vehicle mileage tax (.04/mile)
- Diesel to electric train conversion
- Truck-to-train mode shift

Electricity generation options:

- Upgrades to Chemical boiler cogeneration
- Landfill gas combustion
- Use of Animal manure for generation
- Wood waste combustion
- Agricultural waste combustion
- Wind power
- Nuclear power

Industrial:

- Petroleum refining process improvements
- Pulp and Paper process improvements
- Aluminum Process improvements

Forestry:

- Tree planting programs

Sample of existing Washington policies that reduce greenhouse gas emissions³:

- Encourages cities to set up trip reduction ordinances for employers to reduce employee VMTs
- Promotes "Rideshare" or carpooling
- DOT provides a train for farmers to ship grain to river barges
- State Fleet efficiency standards
- Proposed gasoline tax, FeeBate system, higher parking fees, and education programs
- High Technology Product Manufacturers Excise Tax Exemption (Sales)
- Washington State University Energy Program (Research & Outreach Centers)
- Net Metering law

Benefits of Reduced Reliance on Fossil Fuels: Increased opportunities for Washington

Increases in renewable energy use and energy efficiency improvements would provide new economic opportunities for many industries. Some states already reap significant benefits from reduced reliance on fossil fuels. For example, 33% of all U.S. solar collector shipments, valued nationally at \$29.8 million in 1996 (EIA Renewable Energy Outlook 1997), originated in California. Similar industries in Washington could experience gains from a shift away from fossil fuels.⁴

Inverter-related Products and Services in Washington:

- *Companies include:* Adept Controls, Inc. in Gig Harbor, Cruising Equipment Co. in Seattle, Philtek Power Corporation in Blaine, and Trace Engineering in Arlington.

Solar- and PV-related Products and Services in Washington:

- *Companies include:* Alpine RV INC. in Bremerton, Alternative Energy Applications in Puyallup, Amp Electric Inc in Clayton, Delta F Corporation in Seattle, Energy Innovations Inc in Monroe, Heart Interface in Kent, Inland Generator in Spokane, Integrated Solar Syst in Friday Harbor, Lower Vly Energy Service Ct in Grandview, Lucas Industrial Control in Buckley, PFG Industries, LLC in Vashon, Rainshadow Solar in Orcas, RV Solar Systems in Airway Hts (Spokane) and Airway Heights, Sound Solarium in Tacoma, Stirling Technology Company in Richland, Structures Ltd in Tacoma, Sun Wind Concepts in Camano Island, SUNDANCE Energy Services, Inc. in Bothell, Sunlok in Kirkland, Tate John A & Sons in Bellevue, Thermal Company in Kirkland, and Tri Wind Solar Energy Systems And Products in Yelm.

Electric Vehicle-related Products and Services in Washington:

- *Companies include:* American Flywheel Systems in Medina, Beetles Unlimited in Seattle, Eco-Motion Electric Cars in Seattle, Electric Car Company in Everson, Northwest Electric Car in Olympia, and Wilde EVolutions, Inc. in Port Townsend.

Hydro-related products and services in Washington:

- *Companies include:* Bio-Radiant Energy, Inc. in Woodinville, and Hydro Technology Systems Inc. in Chattaroy,

Wood- and Biomass-related products and services in Washington:

- *Companies include:* Snorkel Stove Company in Seattle, and Stirling Technology Company in Kennewick.

Win-Win Climate Mitigation Projects in Washington (as of November 1997) ⁵

The Cities of Burien, Olympia, and Seattle and the State and Local Climate Change Program

- As participants in the Cities for Climate Protection Campaign, Burien, Olympia, and Seattle have each committed to conducting an emissions inventory, to adopting an emissions reduction target, and to implementing a strategy to achieve their target.

Seattle City Light Company and Climate Wise

- Seattle City Light Company is the first public utility to sign on as a Climate Wise Ally to recruit and provide technical assistance for energy efficiency measures to local area industries.

All Service All Packaging and Waste Wise

- A.S.A.P. (All Service All Packaging) recycled 1,340 pounds of packaging materials including paper, plastic and steel.

Seattle University and Waste Wise

- Seattle University conserved 2,000 lbs of copier paper by eliminating the use of some unnecessary forms. In addition, the University donated, rather than sending to a landfill, over 10 tons of wood products and materials removed from a residence hall during a renovation project.

Winrock International and Joint Implementation

- Winrock International of Snohomish, Cinergy Corporation of Cincinnati, Ohio, and Utilitree of McConnellsville, Ohio are participating in the Rio Bravo Carbon Sequestration Joint Implementation project in Belize. They estimate that over 6 million metric tons of CO₂ will be reduced over the lifetime of the project.

Winrock International and Joint Implementation

- Winrock International of Snohomish, American Electric Power of Columbus, Ohio, and British Petroleum American of Cleveland, Ohio are participating in the Noel Kempff Mercado Climate Action Report Joint Implementation project in Bolivia.
- The developers estimate that over 50 million metric tons of CO₂ will be reduced over the project lifetime.

NOTE: This compilation is a work in progress. For comments, corrections, questions, or additions, please contact Denise Mulholland of the U.S. EPA State and Local Climate Change Program at 202-260-4005 or mulholland.denise@epa.gov.

¹ Source: *Greenhouse Gas Mitigation Options for Washington State*, Washington State Energy Office, 1996.

² Source: Ibid.

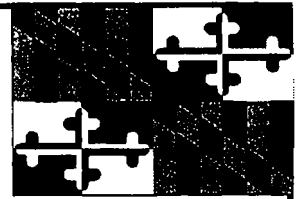
³ Sources: *National Conference of State Legislatures Energy Newsletter*, Vol.4, Number 3, Winter 1997; *The Green Power Network*, U.S. Department of Energy EREN, www.eren.doe.gov/greenpower, October 5, 1998; *State Renewable Energy News*, Volume 6, No.1, Winter 1997, NARUC Subcommittee on Renewable Energy; *Green Power Newsletter*, Number 6, March 1998, The Regulatory Assistance Project, www.rapmaine.org; Colorado Wind Power Buyers, Land and Water Fund of the Rockies, September 1998; Colorado Solar Energy Industries Association, www.coseia.org/rebate.html, August 1998; *Renewable Energy Sourcebook: A Primer For Action*, Public Citizen, www.citizen.org/CMEP/renewables, June 1998; *Green Power Notes*, Center for Energy Efficiency and Renewable Technologies (CEERT), Center for resources Solutions (CRT), and Renewable Energy Marketing Board (REMB), www.cleanpower.org and www.green-e.org, June 1998; *The States and Global Climate Change: Adopted and Proposed Initiatives*, Submitted by The Center for Policy Alternatives, prepared by The Harrison Institute for Public Law, 1997; *State and Local Legislative and/or Administrative Actions Having Direct or Incidental Effects on Greenhouse Gas Emissions*, Center for Global Change, April 1992; *Database of State Incentives for Renewable Energy*, North Carolina Solar Center and Interstate Renewable Energy Council (IREC), www-solar.mck.ncsu.edu, May 1998; *Government Actions on Climate Change in the Metropolitan NY/NJ/CT Region*, Regional Plan Association, March 1998;

⁴ *The Source for Renewable Energy*, <http://www.sourceguides.com/energy/businesses>, October 1998.

⁵ *U.S. Communities Acting to Protect the Climate: A Report on the Achievements of ICLEI's Cities for Climate Protection - U.S.*, International Council for Local Environmental Initiatives, November 1997; EPA Program Managers as of November 1997. For further information, please see www.epa.gov/globalwarming.



\$222 million will be saved by Maryland companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



More ENERGY STAR Facts

- Maryland is home to 392 companies and public entities participating in ENERGY STAR partnerships.
- Over 220 million square feet of Maryland building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area more than 1500 times the size of the National Aquarium in Baltimore.
- 7 ENERGY STAR-Labeled Product manufacturers are located in Maryland.
- Investments already made through the ENERGY STAR program in Maryland will prevent 8 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 1 million acres of trees — an area 940 times the size of the University of Maryland-College Park.
- Nitrogen oxide (NO_x) emissions will be reduced by 21 million pounds and sulfur dioxide (SO₂) by over 59 million pounds due to existing ENERGY STAR investments in Maryland.

Highlights

- Centex Homes received an ENERGY STAR Homes Certificate of Distinction in 1996.
- Sligo Adventist School received the Green Lights Non-Profit Partner of the Year Award in 1995.
- Primo Lighting Management received the Green Lights Lighting Management Ally of the Year Award in 1994.

Market Potential

- Maryland has 1.5 billion square feet of ENERGY STAR Buildings- upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$476 million would be saved annually
 - The following emissions would be prevented each year:
 - 14 billion pounds of CO₂
 - 40 million pounds of NO_x
 - 123 million pounds of SO₂

MARYLAND

ENERGY STAR Participants in Maryland

Aardvark Swim & Sport
 Abaris Realty Incorporated
 Adventure Comics
 American Association of Colleges
 Osteopathic Medicine
 The City of Annapolis, Maryland
 Anne Arundel Community College
 Anne Arundel County, Maryland
 Aspen Systems
 Auto City Body Shop
 Baltimore County Schools, Maryland
 Baltimore Booth
 Baltimore Gas & Electric Co.
 The City of Baltimore, Maryland
 Baltimore County, Maryland
 Ben & Jerry's
 Ben Arundel Hospital, Inc
 Bike-A-Rama
 BioWhittaker Inc.
 Blanca Flor
 Blimpie
 Brookshire Hotel
 Brother International Corp.
 Building Environmental Science &
 Technology
 Carol's Crafts
 CAS Engineering
 CMC Energy Services
 Caterair International
 Celeste Industries Corporation
 Chesapeake Bay Foundation
 The Town of Cheverly, Maryland
 Children's Hospital/Ctr for Reconstructive Surg.
 PSI Technologies
 Citizens Bank of Maryland
 Crabtree & Evelyn
 Dominos Pizza
 Dutch Craftsman Baseball Bat Co
 Eastalco Aluminum Company
 Eastern Metallizing Incorporated
 Eastern Specialty Products
 Energy Conservation Management, Inc.
 Equine Industries
 Frederick Veterinary Center
 Gaithersburg Rental Center
 General Nutrition Centers
 Golden Needle
 Golf Inc.
 Good After New
 Goshen Plaza Beer & Wine
 Great American Photo Lab
 GreenStone Industries, Inc.
 Hechinger
 The Humane Society of the United States
 International Paper - Odenton, MD Facility
 Johns Hopkins University, Montgomery
 County Center
 Laury's Horse Training
 Lee E. Stine, Inc.
 Leonard Rubinstein, D.D.S.
 Liberty Village Development
 Lighthouse Fine Art & Customer Framing
 Loews Annapolis Hotel
 Lombardis
 Maryland Association of Counties
 Maryland Brush Company
 Maryland Chamber of Commerce

Maryland Ensemble Theatre
 Maryland Historical Society
 Maryland Hospital Association
 Maryland Municipal League
 Maryland Science Center
 The State of Maryland
 Miltec Corp
 Mitch and Bills Exxon
 National Association of Physicians for the
 Environment
 National Electrical Contractors Association
 Nationwide Insurance
 New York J & P Pizza
 Nicks Shoe Repair
 Nite Lites
 Normandy Custom Cleaners
 Normans Farm Markets
 North Arundel Hospital
 Northwest Hospital Center
 ORourke
 PC & Art Fine Custom Framing
 PC Paging
 PDR Internet Services, Inc.
 PHH Corporation
 Palais Royal
 Pamplermousse
 Parcel Plus
 Past & Present Shop
 Pastalicious
 Phantasmagoria Records
 Plants Etc Inc
 Pohanka Automotive Group
 Potomac Amoco
 Potomac Florist
 Potomac French Bakery
 Preston Trucking
 Primerica Financial Services
 Quebecor Printing, Glen Burnie, MD
 Queen Annes County, Maryland
 Quest Computers
 Quince Orchard Veterinary Hospital
 R A C Solutions
 R.M. Thorton, Inc.
 Ranger Surplus Plus
 Record Gallery
 Republic Foods Inc.
 Research Cafe
 Research Center Deli
 Rickys Rice Bowl
 Ridgewells Caterers
 Robert & Co.
 Roby's Video Cassette Rental
 Rock Creek Valet
 Rockshire
 Rockville Harley Davidson
 Rockville Soccer Supplies
 Rojos Subs t/a Subway
 Rubino & McGheehan
 Sam Pathi Photography
 Saah Unfinished Furniture
 Saint Agnes Hospital
 Salon Lore
 Salon Salon
 Sandy Spring National Bank
 Sansar
 Schmidt Services Group
 Scopin Bros., Inc

Second Story Books
 Secrete
 Shane Companies
 Sheryl Leonard Galleries
 Shoe Loft
 Signs By Tomorrow
 Sinai Hospital of Baltimore, Inc.
 Sligo Adventist School
 Sonali Boutique & Silk House
 South Philly Cheesesteaks
 Southern Maryland Electric Cooperative
 Special Tees, Inc.
 Spring Electric Supply
 Spring Mill Bread Co
 St. Elmos Café
 Starlab
 Steve Smith Properties, Inc
 Stone Ridge School of Sacred Heart
 Subway Shop, Crabbs Branch
 Sun Day Campaign
 Sunaholic Tanning Studios
 Sunburst Tanning Salon
 The City of Takoma Park, Maryland
 Tally-Ho Restaurant
 Technical Resources International,
 Inc. (TRI)
 Tektronix, Inc.
 Tel Aviv Café
 Temple Beth AMI
 Thayer Enterprises
 The Crafty Fox Shop
 The Frame Rack
 The Perfect Balance
 The Whole Kaboodle
 Thomas W. Glass, DDS
 Traffic Monitoring Technologies
 Travilah Beer & Wine
 Treasures
 Tristate Electrical Supply Co., Inc.
 Twinbrook Computer & Video
 Solutions
 Type Works Plus Inc.
 Air National Guard
 US Army Aberdeen Garrison Proving
 Ground
 US Generating Company
 US NASA Goddard Space Center
 National Naval Medical Center
 The National Security Agency
 US Naval Academy
 US Postal Service Baltimore
 Associated Offices
 Uniformed Services University
 USF&G
 Unitarian Universalist Church of
 Annapolis
 United Futons Inc.
 Valley Motors Incorporated
 Village Eye Center
 Walker Supply Company
 WHFS Radio
 W.W. Taylor Associates
 Washington County Health System
 Whirligigs & Whimsies
 Wintergreen Cleaner
 Worton Creek Marina, Inc.
 ZYZYK

Examples of Maryland Partners Saving Money and Helping the Environment

Baltimore County

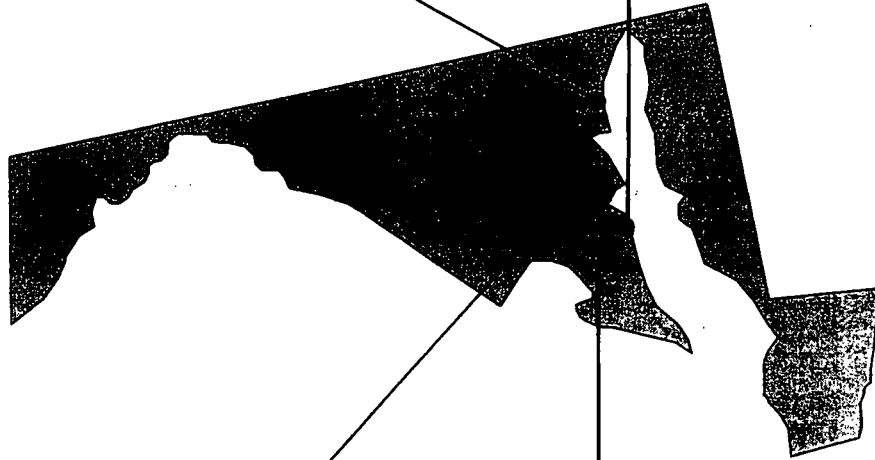
"Joining the program raised enough awareness and interest to begin [an energy initiative]. Now, the County realizes tremendous cost savings from its upgrades."

— Bud Oettel, Asst. Chief Building Services

- Saving \$200,000 in annual energy costs
- Embarked on a plan to perform whole-building energy efficiency upgrades on its buildings
- Reducing energy use by 5.3 million kWh annually
- Preventing 7.8 million pounds of CO₂ annually

Anne Arundel County Public Schools

- Saving \$1 million in annual energy costs
- Reducing energy use by 14 million kWh annually
- Preventing 28 million pounds of CO₂
- Able to rechannel funds to resources like teachers and books



Montgomery County

"Funds freed from utility bills can be applied to other pressing community needs, such as community policing or extended library hours."

— Fred Edwards, Chief of Capital Projects

- Saving \$360,000 in annual energy costs
- Reducing energy use by 5 million kWh annually
- Preventing 9 million pounds of CO₂ annually
- Newly-constructed Upcounty Government Center is a model of energy efficiency and is the most inexpensive County building to operate, with an annual energy cost of only \$1.00 per square foot.

Citizens Bank, Laurel

- Saving \$180,000 in annual energy costs
- Upgraded lighting in 670,000 sq. ft.
- Reducing energy use by 2.7 million kWh annually
- Preventing 5.4 million pounds of CO₂ annually

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Maryland



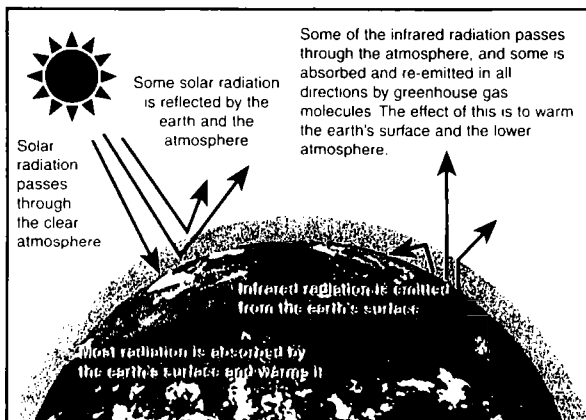
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

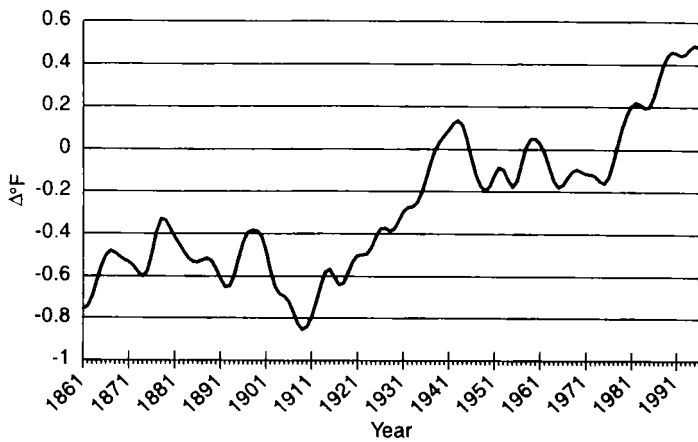
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as

well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

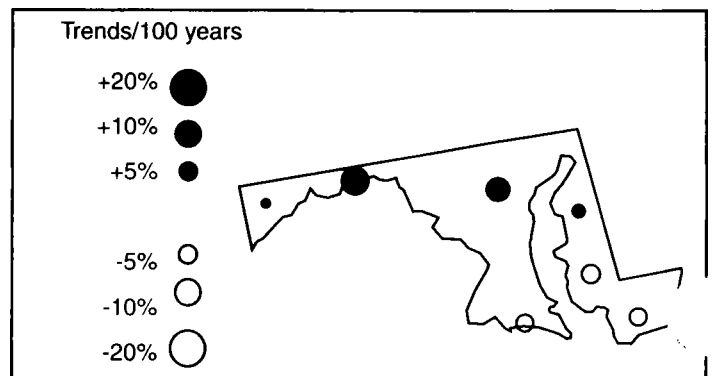
Over the last century, the average temperature in College Park, Maryland, has increased 2.4°F, and precipitation has increased by up to 10% in many parts of the state. These past trends may or may not continue into the future.

Over the next century, Maryland’s climate may change even more. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Maryland could increase by 3°F (with a range of 1-7°F) in spring and 4°F (with a range of 2-9°F) in the other seasons. Precipitation is projected to increase by 20% (with a range of 10-40%) in all seasons, probably slightly less in spring and fall and slightly more in winter. Other climate models may show different results, especially regarding estimated changes in precipitation. The impacts described in the sections that follow take into account estimates from different models. The amount of precipitation on extreme wet or snowy days in winter is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. Although it is not clear how the severity of storms might be affected, an increase in the frequency and intensity of winter storms is possible.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Maryland, with its irregular, intense heat

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

waves, could be susceptible. One study projects that in Baltimore, a warming of 3°F could increase heat-related deaths by 50% from the current 85 to 130, and in Washington, D.C., results indicate slightly smaller increases (although increased air conditioning may not have been fully accounted for in both estimates). This study also projects that winter-related deaths in Baltimore should remain unaffected, but could increase by a third in Washington, D.C. The exact reasons for these differences are unknown. The elderly, especially those living alone, are at greatest risk.

Climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. In the eastern mid-Atlantic region, a 4°F warming, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by 4%. Currently, ground-level concentrations exceed the national ozone health standard throughout the state. Nearly all of Maryland is classified as a nonattainment area for ozone. Serious to severe nonattainment areas include Baltimore and the suburbs of Washington, D.C. Ground-level ozone is associated with respiratory illnesses such as asthma, reduced lung function, and respiratory inflammation.

Mosquitos carrying malaria, dengue fever, and St. Louis encephalitis are present in Maryland. Warm, wet conditions could increase mosquito populations, increase biting rates, and reduce the incubation rate of the viruses and parasites within them. The incidence of Lyme disease could also increase as warmer temperatures and increased precipitation enhance the habitat for ticks and their rodent hosts. Warmer winters, warmer temperatures, and heavy precipitation also can increase harmful algal blooms, that is, red tides; reduce water quality; and increase the potential for outbreaks of cryptosporidiosis and giardia. These impacts, however, can be minimized through existing disease prevention and control methods.

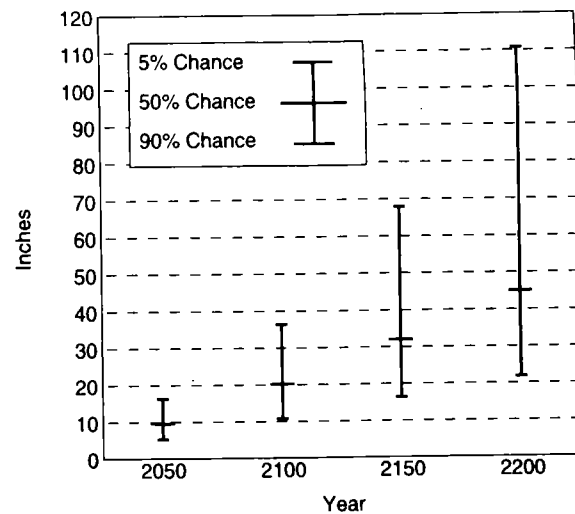
Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

Maryland has 3,100 miles of tidally influenced shoreline. It consists of barrier islands such as Assateague Island, the highly urbanized and developed oceanfront of Ocean City, and the extensive eastern shore of Chesapeake Bay. The eastern shore of Chesapeake Bay in Maryland has an extensive array of tidally influenced freshwater and salt marshes, forested wetlands, riverine wetlands, and open water.

In Baltimore, sea level already is rising by 7 inches per century, and it is likely to rise another 19 inches by 2100. Human activities such as impounding and dredging as well as sea level rise have caused extensive losses of coastal wetlands and marshes in both the Chesapeake Bay and Assateague Island regions. With

Future Sea Level Rise At Easton



Sources: Lyles et al. (1988); EPA (1995)

higher sea levels, Assateague Island is likely to migrate toward the mainland as sand is eroded on the ocean side and deposited on the mainland side, and the island's native plant communities, which include some threatened species, are likely to change in distribution and diversity. The 9-mile coastline of Ocean City, which was nourished by a \$30 million beach nourishment project in the late 1980s, could be threatened by a rise in sea level.

The cumulative cost of additional sand replenishment to protect Maryland's coastline from a 20-inch sea level rise by 2100 is estimated at \$35-\$200 million. However, sand replenishment may not be cost-effective for all coastal areas in the state and, therefore, some savings could be possible.

Water Resources

Without increases in precipitation, higher temperatures and increased evaporation would lower streamflows, lake levels, and groundwater levels in the summer and fall. This could adversely affect the many instream uses of water in Maryland, including hydroelectric power generation, navigation, marine commerce, commercial and sport fishing, and recreation. Water supplies for the large and growing metropolitan areas surrounding Baltimore and the District of Columbia could suffer from lower summer streamflows. Drier summer conditions also could reduce groundwater levels, which could be significant for parts of Charles and Prince Georges counties in southern Maryland, which are already experiencing declines in groundwater levels. Groundwater is also the primary source of water for domestic use and irrigated agriculture on the Eastern Shore. Additionally, low flows and higher temperatures in the summer could affect water quality, further aggravating problems with nuisance algae, low dissolved-oxygen levels, and bacterial contamination in urban streams.

If, however, rainfall and runoff increase in the Maryland region, the resulting higher streamflows could alleviate water supply problems and dilute pollutants, although more flooding could occur. Higher runoff also could increase erosion and levels of pesticides and fertilizers from agricultural areas. These chemicals reduce oxygen and limit the types of species that can live in the

rivers. Increased runoff from farmlands would exacerbate this effect. It also could increase erosion and pollution from urban and strip mining areas. Although many sources of pollution into Chesapeake Bay have been controlled, runoff containing nutrients, heavy metals, and sediment remains a problem in many tidal areas. Acid mine drainage is also a concern in westernmost Maryland.

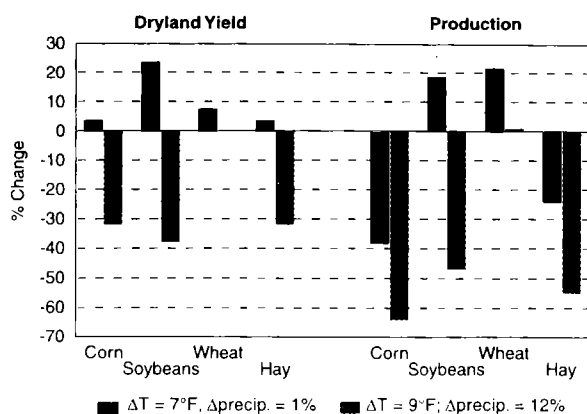
Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other users.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, crop pests, changes in air pollution such as ozone, and adaptation by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

In Maryland, production agriculture is a \$1.3 billion annual industry, 60% of which comes from livestock, mainly cattle. Very few of the farmed acres are irrigated. Climate changes could reduce the farmed acres of major crops such as corn, soybeans, wheat, and hay by 24-43%, in response to changes in yields and resulting economic conditions. Projected changes in yields vary widely, depending on how climate changes and whether land is irrigated. For example, under severe conditions, corn and hay yields could fall by 32% and soybeans by 38% as temperatures rise beyond tolerance levels of the crop. Less severe changes, however, could result in increases of 4% and 24%, respectively, as soil moisture and carbon dioxide levels rise.

Changes In Agricultural Yield And Production



Sources: Mendelsohn and Neumann (in press); McCarl (personal communication)

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species composition, geographic range, and health and productivity. If conditions also become drier, the current range of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to warmer conditions, such as southern pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if the change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

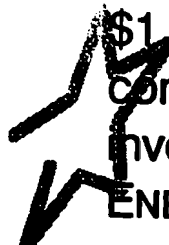
With changes in climate, the extent and density of forested areas in Maryland could change little or decline by as much as 5-10%. However, the types of trees dominating Maryland forests are likely to change. The warmer mixed forests, dominated by southern pines and oaks, would spread northward, replacing the predominantly hardwood forests currently found in the northern and western sections of the state. Maritime forests, important for their recreational and aesthetic value and for their role in coastal hydrology, could be affected adversely by changes in the frequencies of large storms associated with climate change (hurricanes in the late summer and fall, nor'easters in the winter and spring). Coastal estuaries are breeding grounds for important commercial fish and shellfish species, and changes in the hydrology of upland forests in Maryland could have profound effects on these sensitive coastal systems.

Ecosystems

The diverse habitats of Maryland's Chesapeake Bay (including underwater grass beds, salt marshes, forested wetlands, and upland forests) provide a home for more than 2,700 species of animals and plants. The Blackwater Wildlife Refuge on the eastern shore of the bay has the largest concentration of nesting bald eagles on the east coast north of Florida, and is vital for migratory waterfowl and shorebirds. These wetlands are also important agents of flood control and water quality.

Chesapeake Bay has already begun to feel the effects of sea level rise. Rising sea level enables saltwater to penetrate farther inland and upstream, and the more than 150 streams and rivers that flow into the bay could be affected. Intruding salt water and increasing sedimentation are choking many marshes. Since 1938, the rising sea has destroyed one-third of the marsh at Blackwater. Most of the remaining marsh in this area is projected to disappear within 30 years. Inundation of lowland habitats surrounding the marshes could result in the disappearance of habitat for migratory birds and other species, for example, the endangered Delmarva fox squirrel.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460, or visit <http://www.epa.gov/globalwarming/impacts>.



\$1 billion will be saved by New York companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.

More ENERGY STAR Facts

- New York is home to 244 companies and public entities participating in ENERGY STAR partnerships.
- Over 800 million square feet of New York building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 1,000 times the size of Madison Square Garden.
- 19 ENERGY STAR-Labeled Product manufacturers are located in New York.
- Investments already made through the ENERGY STAR program in New York will prevent over 38 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 5 million acres of trees — an area 6,000 times the size of Central Park.
- Nitrogen oxide (NO_x) emissions will be reduced by over 59 million pounds and sulfur dioxide (SO₂) by over 160 million pounds due to ENERGY STAR programs in New York.

Highlights

- IBM Corporation (Armonk) received the ENERGY STAR Office Equipment Computer Partner of the Year Award in 1999 and 1998.
- Xerox received the ENERGY STAR Office Equipment Best Promotion Award in 1998.
- Canon USA received the ENERGY STAR Office Equipment Facsimile Partner of the Year Award in 1997 and Copier Partner of the Year Award in 1996.
- The University of Rochester received the Green Lights University Partner of the Year in 1997; Columbia University received the award in 1996.
- Carrier Corporation received an ENERGY STAR HVAC Certificate of Distinction in 1996 and is an ENERGY STAR loan partner.
- Landmark buildings including the World Trade Center, Empire State Building, Time Life Building, and American Express Tower have expressed their commitment to being among the top 25 percent in energy performance nationally.

Market Potential

- New York has 5 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$1 billion would be saved annually
 - The following emissions would be prevented each year:
 - 27 billion pounds of CO₂
 - 47 million pounds of NO_x
 - 124 million pounds of SO₂

NEW YORK

E ENERGY STAR Participants in New York

55 Broad Street Company
ABB Instrumentation
Incorporated
ABD Lighting Management
Adelphi University
Adco Lighting
Adco Lighting and Energy
Conservation
Aladdin Lighting Supply
Albany Medical Center Hospital
Allegheny Power Service
Company
American Broadcasting
Companies, Inc.
American Express
American Lighting Association
American Scientific Lighting
Atlite Lighting
Audubon Society of New York
State, Inc.
Avon Products Incorporated
Axiohm IPB
Barr Laboratories
Bausch & Lomb
Bear Stearns Companies, Inc.
BMG/RCA Music
Bonded Insulation Company,
Inc.
Boundless Technologies
Brooklyn Union Gas Co.
Buffalo State College
Candela Systems Corporation
Carrier Corporation North
America
Citicorp/Citibank
City of New York
City of White Plains, New York
City University of New York
College of Saint Rose
Columbia University
Con/Serve Electrical Supply
Company
Connetquot Central School
District
Consolidated Edison of New
York, Inc.
Continental Insurance
Cosmair, Inc.
Council of State Governments
County of Nassau, New York
County of Rockland, New
York
Crownlite Manufacturing Corp.
Danka Corporation
Dean Witter Realty
Decotex 2000 Corporation
Dresser Rand
Dunkirk Radiator
Eastman Kodak Company

Edison Price Lighting
Electric Conservation and
Supply Company
Energy Specialties, Inc.
Energave, Incorporated (NY)
Environmental Action Club of
Skidmore College
Envirotherm Heating and
Cooling Systems Inc.
Environmental Defense Fund
Environmental Energy
Erik Lighting, Inc.
Estee Lander Incorporated
Fordham Preparatory School
Full Circle Incorporated
Genesee Mercy Healthcare
Genovese Drug Stores Inc.
Godfrey Realty Company, Inc.
Guy Carpenter and Company
Hazeltime Corporation
Hofstra University
Home Box Office
Horton Memorial Hospital
HVS Eco Services
IBM Corporation
Infocex Corporation
International Paper/Kraft
Packaging Division
ITT Corporation
ITT Industries, Incorporated
JE Seagram Corporation
Johnson & Higgins Kentucky
Army National Guard
LaMar Lighting Company
Lamp Technology, Inc.
Legion Lighting Company, Inc.
Lerner New York
Lighttron of Cornwall, Inc.
Link International Inc.
Liz Claiborne, Inc.
Lockheed Martin Corporation
Long Island Associations, Inc.
Long Island Lighting Company
(LILCO)
Long Island University
Southampton College
Lutheran Medical Center of
New York
Luxo Corporation
Marine Midland Bank
Medeva Pharmaceuticals
Manufacturing Inc
MirrorLight, Inc.
ML Systems Corporation
Mount Sinai Hospital
National Assn. of Power
Engineers, NY Chap #24
National Broadcasting
Company, Inc.

National Earth Science Teachers
Association
National Westminster Bancorp
Inc.
NBS Consultants
New York Institute of
Technology Main Campus
New York Life Insurance &
Annuity Corp.
New York Marriott Marquis
New York Power Authority
New York State Office of
Mental Health
NRG Consultants, Inc.
NYNEX Corporation
Orange and Rockland Utilities
 Pace University
PaineWebber Incorporated
Pass & Seymour/LeGrand
PepsiCo, Inc.
Pfizer, Inc. (NY Headquarters
Facility)
Philips Electronics North
America Corp.
Pike County Light and Power
Co.
Port Authority of NY/NJ
George Washington
Bridge
Port Authority of NY/NJ
Holland Tunnel
Port Authority of NY/NJ
Lincoln Tunnel
Port Authority of NY/NJ
Newark Airport
Port Authority of NY/NJ,
PATH
Port Authority of NY/NJ Bus
Terminal
Port Authority of NY/NJ
Newark Legal Cntr.
Port Authority of NY/NJ Port
Newark/Port Elizabeth
Port Authority of NY/NJ
World Trade Center
Quebecor Printing Buffalo, Inc.
Radio Catskill (WJFF,
Jeffersonville)
Reflective Light Technologies
Rensselaer Polytechnic Institute
Rochester City School District
Rochester Institute of
Technology
Sachem Central School District
Science Teachers Association of
New York State
Science Technical Assistance
Center
Self-Powered Lighting, Inc.

Sica Electrical & Maintenance
Siemens Corporation
SIR Industries, Inc.
Slant/Fin Corporation
Sony Pictures Entertainment
St. Regis Mohawk Tribe
Staff Lighting Corporation
Standard Microsystems
Corporation
State of New York
State University of New York at
Stony Brook
State University of New York
System
Student Assn. of SUNY at
Orwego
Student Government Assn. of
Skidmore College
Student Senate of Alfred
University
Swift Electrical Supply
Company
Texaco
Terfi Blends
The Bulb Manufacturers
The Chase Manhattan Bank
The Melville Corporation
The Organization for Green
Living: Alfred University
The Prichett Wilson Group
Incorporated
TOOK, Inc.
Toshiba America
Toshiba America Cons Prod
Ulster Precision Inc.
Unilever U.S.
Union College
United States Military Academy,
West Point, NY
Unitrac Energy Management
Company
University of Rochester
Utica Boilers
Vassar College
Veterans Affairs Medical Center,
New York
WAC Lighting
Water Furnace
Western Queens Community
Hospital
Wiedenbach-Brown Company,
Inc.
Wildlife Conservation Society
Xerox Corporation

Examples of New York Partners Saving Money and Helping the Environment

University of Rochester, Rochester

"The University is pleased to be recognized as a leader in reducing pollution and energy consumption. Upgrading to more efficient lightings systems makes good business sense."

—Patricia Beaumont

- Saving \$934,000 in annual energy costs
- Upgraded lighting in more than 100 buildings
- Reducing energy use by 8.3 million kWh annually
- Preventing 13 million pounds of CO₂ annually

New York State Office of Mental Health, Albany

"Energy conservation reduced costs and provided a better patient environment."

—Neill Anderson, Director of Engineering

- Saving \$970,000 in annual energy costs
- Reduced net energy use 42 percent since 1989
- Reducing energy use by 11.5 million kWh annually
- Preventing 17.8 million pounds of CO₂ annually



City University of New York, New York

- Saving \$5.5 million in annual energy costs
- On track to reduce net energy use 20 percent by the year 2000
- Reducing energy use by 70 million kWh annually
- Preventing 100 million pounds of CO₂ annually
- Participant in New York Power Authority's High Efficiency Lighting Program (HELP)

Northrop Grumman Corporation, Bethpage

- Saving \$675,000 in annual energy costs
- Upgraded more than 60 percent of lighting
- Reducing energy use by 8 million kWh annually
- Preventing 11 million pounds of CO₂ annually

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$3.5 billion and prevent 78 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3000 participants, representing close to one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. Consumers are now saving over \$1 billion a year by bringing ENERGY STAR products into their homes.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And New York

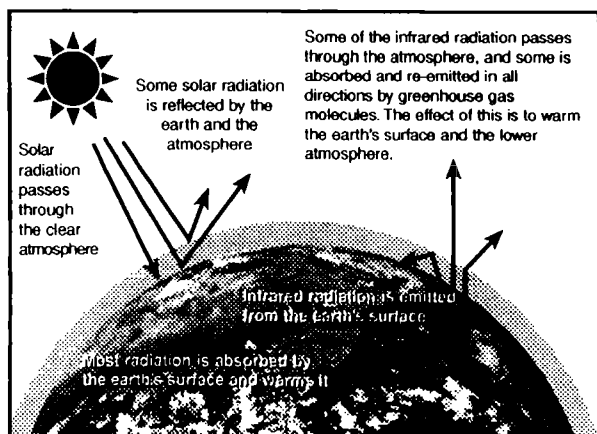
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

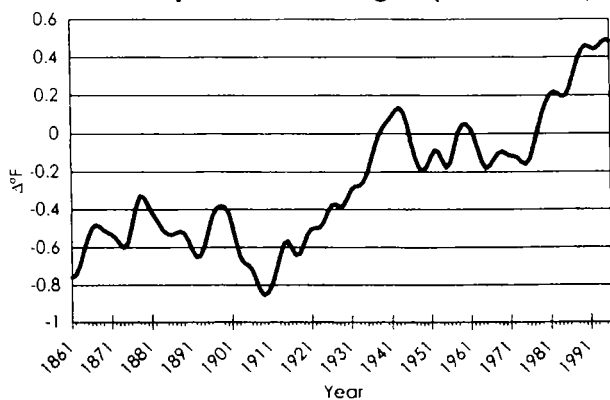
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Local Climate Changes

Over the last century, temperatures in Albany, New York, have warmed by more than 1°F, and precipitation throughout the state has increased by up to 20%.

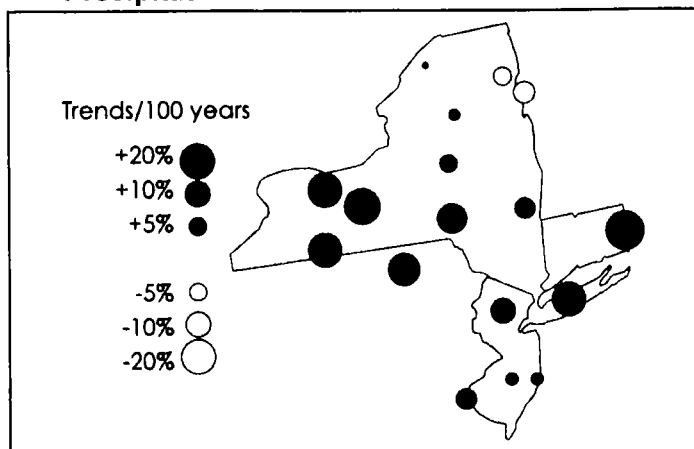
Over the next century, New York’s climate may change even more. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that has accounted for both greenhouse gases and aerosols, by 2100 temperatures in New York could increase about 4°F in winter and spring, and slightly more in summer and fall (with a range of 2-8°F). Precipitation is projected to increase by 10-20% (with a range of 0-40%), with slightly less change in spring and slightly more in winter.

The amount of precipitation on extreme wet (or snowy) days is likely to increase, but changes in the lengths of wet or dry spells are not clear. The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms such as hurricanes would change.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. New York, with its irregular, intense heat waves, could be especially susceptible.

In New York City, one study projects that a 1°F warming could more than double heat-related deaths during a typical summer, from about 300 today to over 700 (although increased air conditioning use may not have been fully accounted for). Decreases in winter mortality probably would be less than the summer mortality increases if the climate warms. The elderly, particularly those living alone, are at greatest risk.

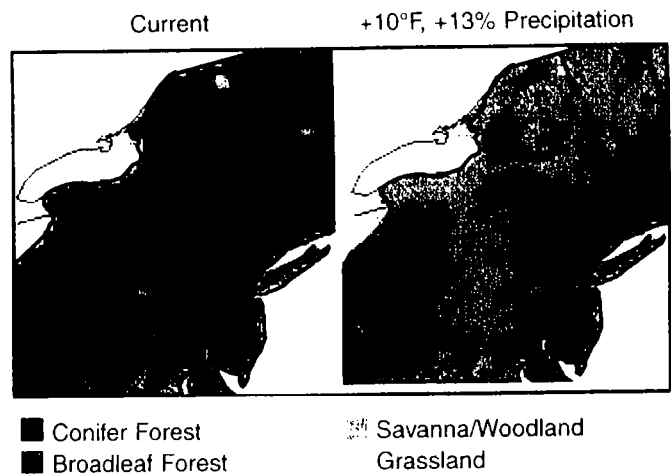
There is concern that climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbons emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

A 4°F warming in New York City, with no other change in weather or emissions, would increase concentrations of ground-level ozone, a major component of smog, by 4%. Current ozone concentrations exceed the national health standards in many urban areas, especially New York City and Long Island. Ground-level ozone has been shown to aggravate existing respiratory illnesses such as asthma, reduce lung function, and induce respiratory inflammation. In addition, ambient ozone reduces agricultural crop yields and impairs ecosystem health.

Warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitoes flourish in some areas around New York City. Some can carry malaria, while others can carry Eastern equine encephalitis, which can be lethal or cause neurological damage. Lyme disease, which is carried by ticks, has increased in New York. If conditions become warmer and wetter, mosquito and tick populations could increase, thereby increasing the risk of transmission of these diseases.

In addition, warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. These blooms damage habitat and shellfish nurseries, can be toxic to humans, and can carry bacteria, like those causing cholera. Brown algal tides already are prevalent in the Atlantic. Warmer ocean waters could increase their occurrence and persistence.

Changes In Forest Cover



Source: VEMAP Participants (1995); Neilson (1995)

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. This would include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range of forests might be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to warmer conditions, such as southern pines, would prevail. Forests could, under these conditions, become more dense. These changes might occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in New York could change little or could decline by as much as 10-25%. However, the types of trees dominating New York forests are likely to change. The predominant maple, beech, and birch forests found in northern and western New York would retreat northward. The brilliant autumn foliage of the maples eventually could give way to forests dominated by oaks, ash, and pines. Across the state, as much as 50-70% of the maple forests could be lost. As a result, the character of heavily visited areas such as the Adirondacks may change.

Coastal Areas

Along much of New York's coast, sea level already is rising 10 inches per century, and it is likely to rise another 22 inches by 2100. Sea level rise can lead to flooding of low-lying areas, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

New York has one of the most urbanized coastlines in the United States. Over 20 million people use New York's beaches and coastal regions for recreation each year. New York has been successful at preventing major permanent losses of its beaches

and urban coastline, but sites such as Long Island continue to suffer from chronic beach erosion. Long Island's south shore, which is made up of barrier islands, barrier spits, ponds, and sand beaches, could suffer extensive damage from sea level rise and coastal storms.

Protecting New York's coast would require significant resources and planning. For example, Manhattan's 29-mile coast probably could be protected by raising existing bulkheads and sea walls at a cumulative cost of \$30-\$140 million for a 1-3 foot rise in sea level. The costs of raising existing bulkheads already have begun to accrue, and they could continue throughout the next century.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

Scientists are unable to predict whether streamflow in New York would rise or fall on average. However, there could be higher streamflow in the winter and lower streamflow in spring and summer. Changes in the seasonality of streamflow (more in winter, less in summer) would make it difficult for the water supply systems in cities like New York to meet current demands reliably. In addition, higher temperatures and lower flow could reduce water quality in New York's rivers and streams.

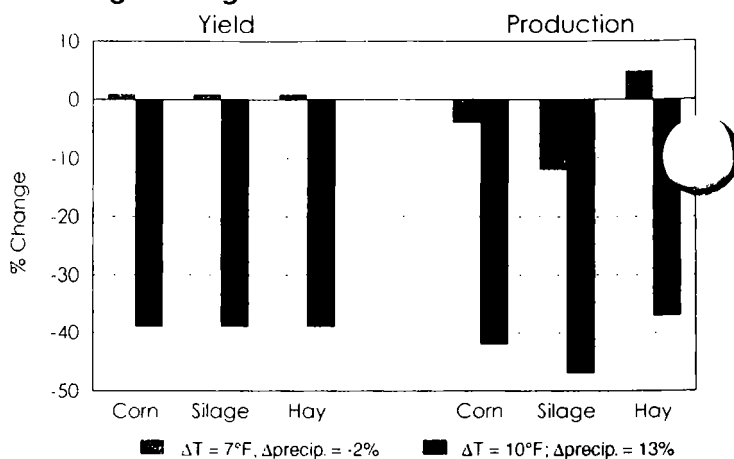
Increased evaporation probably would reduce the average levels of Lakes Erie and Ontario by up to a foot. These changes would exacerbate water quality problems in those lakes, as well as in the numerous smaller lakes in the St. Lawrence River basin. Lower water levels in Lakes Erie and Ontario would reduce flood damages, but shore erosion would increase from wind and rain. The ice-free season for the St. Lawrence Seaway would be longer, with positive benefits to navigation.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

In New York, agriculture is about a \$3 billion a year industry, two-thirds of which comes from dairy livestock. The major crops in the state are hay, corn, and silage. Changes in New York yields could range from 0 to -40%. Climate change could lower production and farm income, but total acres farmed most likely would remain constant. Although very little land is currently irrigated, irrigated acreage probably would increase with climate change.

Ecosystems

The ecosystems of New York are quite diverse, ranging from coastal marshes to mountain forests. These ecosystems would be affected by everything from sea level rise to changes in fires and pest outbreaks. Sea level rise could alter food availability for wading birds and other animals in the coastal areas because of loss of wetlands. In higher elevation wetlands, climate warming could reduce streamflow and lake levels, which would result in losses of vegetation such as cranberries. Brook trout habitat and fisheries, which require cold temperatures, could be lost entirely throughout New York, and most of the habitat for brown trout could be lost.

Adirondack State Park is the largest single forested area east of the Mississippi, consisting of 6 million acres, 2.6 million of which are a forest preserve. The park represents one of the most significant hardwood ecosystems in the world. A warmer climate could change the types and extent of forests. The migration of species to new locations out of the park could be impeded by economic development around the park.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.

Climate Change Mitigation in New York

New York's Greenhouse Gas Emissions, as estimated by the New York State Energy Research and Development Authority (NYSERDA)

- New York's total greenhouse gas emissions in 1996 were about 63 million metric tons of carbon-equivalent, about 4% of the U.S.'s 1996 greenhouse gas emissions. In 1990, New York's greenhouse gas emissions were about 74 million metric tons or approximately 6% of the U.S.'s emissions in 1990.
- Per capita emissions in 1996 were about 3.5 metric tons per person, lower than the 1996 national average of about 6.7 metric tons per person.
- Fuel combustion sources accounted for 91% of the total emissions. Transportation contributed 32%, followed by residential, commercial, and industrial, which contributed 25%, 16%, and 6%, respectively. Sources other than fuel combustion accounted for the remaining 9% of New York's greenhouse gas emissions.
- From 1990 to 1996, New York's total greenhouse gas emissions decreased by 1.4%, although primary energy use increased by 7%. This effect is largely the result of increased use of natural gas in electric generation.

Existing New York Programs and Policies that Reduce Greenhouse Gas Emissions

New York State Energy Research and Development Authority

- ***R&D Programs*** - Develop, demonstrate, and commercialize technologies in Buildings, Industry, Transportation and Power Systems, Energy Resources, and Environmental Research that are designed to improve efficiency and increase the use of renewable resources.
- ***Efficiency Deployment Programs*** - Provide technical assistance, financial incentives, and information to improve energy efficiency. Programs are targeted across the spectrum of commercial, institutional, government, industrial, residential, low-income, and transportation sectors.
- ***New York Energy SmartSM Programs*** - Provide public benefit programs with \$172 million of System Benefits Charge funds over the 1998-2001 period, to improve energy efficiency, promote environmental and strategic research, develop renewable resources and improve low-income energy affordability. Programs include performance contracting, loan funds, comprehensive energy management services, feasibility studies, efficient equipment incentives, environmental monitoring, and renewable resource development.
- ***ENERGY STAR Program*** - New York is the first state to become an ENERGY STAR Partner and now has nearly 250 companies and public entities participating in partnerships, as well as a Public Awareness Campaign targeted to residential customers to promote the purchase and use of energy efficient appliances and equipment.

New York Power Authority

- ***High Efficiency Lighting Program (HELP)*** - Assists local, county and state government facilities, public schools, and state and community colleges with the design, and installation of new lighting, motors, and heating, ventilating and air conditioning

equipment upgrades at no-cost to the participants.

- ***Energy Efficient Refrigerators Program*** - Provides 20,000 new energy efficient refrigerators a year to residents of apartments owned by the New York City Housing Authority. Annual electric-bill savings are expected to reach \$6 million and cut energy use by 63 million kilowatt-hours when all 180,000 refrigerators are replaced over the course of the nine year program.
- ***Technology Development Program*** - Provide research and development in promoting the use of fuel cells, photovoltaics, electric vehicles and relieving electric system bottlenecks by applying new technologies.

Policies that reduce Greenhouse Gas Emissions

- ***Residential Solar Investment Tax Credit/ Net Energy Metering Law*** - Provides a residential investment tax credit for the purchase and installation of residential photovoltaic systems and allows residential customers to sell the output of these systems back to their local utility ("net metering").

Benefits of Reduced Reliance on Fossil fuels: Increased Opportunities for New York

New York encourages and promotes the development of industries that manufacture equipment and products to improve energy efficiency and increase use of renewable resources as a way to stimulate economic growth.

- ***Energy Star products*** - 19 manufacturers located in New York.
- ***Industrial turbines*** - GE Power Generation Product Division in Schenectady, Dresser Industries in Olean, and Turbonetics Energy in Latham.
- ***Solar thermal systems*** - Besicorp in Kingston, Bioenergy Systems in Ellenville, Sun Solar Products in Bohemia, Sunshine Plus in West Babylon, and Conservall in Buffalo.
- ***Insulation*** - Owens-Corning Fiberglass in Delmar.
- ***Motors*** - WEG in Rochester
- ***Other*** - Spectronics manufactures refrigerant leak detection products; Lightron manufactures high-efficiency lighting systems; Dunkirk Radiator manufactures the world's most efficient residential natural gas boiler.

Win-Win Climate Mitigation Projects in New York

- ***New York State Office of Mental Health*** (ENERGY STAR Partner) - Reduced electricity use by 10,300 mWh per year (50% of use), saving \$970,000 in annual energy costs and reducing about 4,400 metric tons of CO₂ annually. Named ENERGY STAR Partner of the Year in 1999.
- ***City University of New York*** (ENERGY STAR Partner) - Reduced electricity use by 70,000 mWh per year, saving \$5.5 million in annual energy costs, and reducing about 32,000 metric tons of CO₂ annually.
- ***Metal Arts Company, Inc.*** (NYSERDA R&D Program Partner) - Developed an electroless nickel-plating process for finishing aluminum products. Compared to conventional processes, the improved process consumes about 30% less electricity, 60% less natural gas, and generates 70% less waste.

- **Lockheed Martin** (NYSERDA R&D Program Partner) - Commercialized the Hybrid Drive System used in hybrid electric transit buses. Five buses have entered revenue service with the New York City Metropolitan Transit Authority, which are the first in the U.S. Compared to conventional buses, the hybrid electric buses use 50% less fuel, resulting in a 70% reduction in tailpipe emissions.
- **Comfortex** (NYSERDA R&D Program Partner) - Working to design a new window treatment for commercial buildings that both insulates and controls the amount of daylight passing through it. Compared to a Venetian blind, the new shade is expected to reduce heating and cooling attributable to windows by 30-50%.
- **NYCO Minerals, Inc.** (NYSERDA Efficiency Deployment Program participant) - Installed compressed air and heat recovery equipment in its facility to mine wallastonite (mineral used in ceramics, plastics, cements, and automotive products), resulting in annual energy savings of over \$40,000. The measures were implemented as a result of NYSERDA's FlexTech Program, which provides technical assistance, and enables many businesses to participate in ClimateWise.
- **Home Box Office** (Green Lights) - Upgraded lighting, reducing electricity use by 791 mWh per year, saving \$70,000 in annual energy costs, and reducing about 340 metric tons of CO₂ per year.
- **Cornell University** (Transportation Partner) - Encourages car pooling, public transit, walking and biking with a variety of market incentives. Saving \$3 million per year in construction costs, debt service and maintenance costs by avoiding a 1,200 space parking garage. Reduced vehicle miles traveled by 10 million miles per year, saving 417,000 gallons of fuel and 3,350 metric tons of CO₂.
- **International Business Machines, Inc.** (ClimateWise and Business for Social Responsibility) - Developed an aggressive energy efficiency program, including energy management systems, reheat energy reduction projects, and re-engineering of product and process design. Actions have saved 100,000 mWh per year, saving over \$7 million in annual energy costs, and reducing about 43,000 metric tons of CO₂ annually.
- **Environmental and Economic Consulting** (Joint Implementation) - Participating in the Reforestation in Volagda project in the Russian Federation, with estimated CO₂ savings of 800,000 metric tons over the lifetime of the project.



Climate Change Mitigation in New York

New York's Greenhouse Gas Emissions¹ *as estimated by the NY State Energy Office*

- Total greenhouse gas emissions in 1990 were about 74 million metric tons of carbon-equivalent, about 6% of the U.S. emissions for that year (U.S. Climate Action Report, U.S. Department of State, 1997).
- Per capita emissions in 1990 were about 4 metric tons per person, lower than the 1990 national average of about 5 metric tons per person.
- Transportation accounted for the highest amount of energy-related greenhouse gas emissions, responsible for 30% of emissions.
- The second largest source of emissions came from electric utilities, with 31%, followed by residential with 14%.

Existing New York Policies that reduce greenhouse gas emissions²:

Sample of Existing Policies or Programs:

- Proposed Net Metering (Bill)
- System Benefit Charges
- Improvement of energy-efficiency in state buildings

Benefits of Reduced Reliance on Fossil Fuels: Increased opportunities for New York

Increases in renewable energy use and energy efficiency improvements would provide new economic opportunities for many industries. Those in some states already reap the benefits of reduced reliance on fossil fuels. For example, 33% of all U.S. solar collector shipments, valued nationally at \$29.8 million in 1996 (EIA Renewable Energy Outlook 1997), originated in California. Similar industries in New York could experience gains from a shift away from fossil fuels.³

Industrial turbines:

- GE Power Generation product Division in Schenectady NY, and Turbonetics Energy in Latham are both NY turbine manufacturers.

Solar Thermal:

- Companies include: Besicorp in Kingston, Bioenergy Systems in Ellenville, Sun Solar Products in Bohemia, and Sunshine Plus in West Babylon.

Insulation:

- Owens-Corning Fiberglass is a NY manufacturer in Delmar, NY.

Motors:

- Manufacturers include Stature Electric in Watertown and KJDE Corp.

Win-Win Climate Mitigation Projects in New York⁴

Home Box Office (HBO) and Green Lights:

- HBO has upgraded lighting throughout its NY buildings, switching to lower wattage lamps, electronic ballasts, and occupancy sensors.
- They have achieved a 35% internal rate of return, saved 791 megawatt hours a year in electricity; saved nearly \$70,000 in annual electricity costs, reduced 300 tons of carbon dioxide, 2 tons of sulfur dioxide emissions and .75 ton of nitrogen oxides annually.

Cornell University and Transportation Partners:

- Cornell University encourages car pooling, public transit, walking and biking with a variety of market incentives.
- Cornell is saving \$3 million a year in construction costs, debt service and maintenance costs because they didn't need to build a 1,200 space parking garage.
- Vehicle miles traveled were reduced by 10 million miles a year, saving 417,000 gallons of fuel, and reducing 3,350 tons of carbon dioxide, 325 tons of carbon monoxide, 17 tons of nitrogen oxides, and 30 tons of hydrocarbons.

The New York State Energy Research and Development Authority (NYSERDA) and Business for Social Responsibility (BSR), International Business Machines, Inc. and Climate Wise:

- In 1996, IBM developed aggressive energy management and control systems, implemented reheat energy reduction projects, and engineering energy efficiency steps into product and process design.
- These actions have saved over 100,000 Mwh, over \$7 million, and over 75,000 metric tons of CO₂ emissions. IBM expects to reduce their energy use 4% annually through the year 2000.

The New York State Energy Research and Development Authority (NYSERDA) and Business for Social Responsibility (BSR), The Metal Arts Company, and Climate Wise:

- The Metal Arts Company through NYSERDA have developed a high phosphorus electroless nickel bath that produces a better product at approximately a 30% reduction in cost for material and energy.

Environmental and Economic Consulting and Joint Implementation

- Environmental and Economic Consulting of New York City is participating in the Reforestation in Vologda Joint Implementation project in the Russian Federation. The developers estimate that over 800 thousands metric tons of CO₂ will be reduced over the lifetime of the project.

NOTE: This compilation is a work in progress. For comments, questions, or additions, please contact Denise Mulholland of the U.S. EPA State and Local Climate Change Program at 202-260-4005 or mulholland.denise@epa.gov.

¹ Source: USEPA Greenhouse Gas Emissions Inventory Database on the EPA Global Warming Website, 1999.

² Sources: National Conference of State Legislatures Energy Newsletter, Vol.4, Number 3, Winter 1997; The Green Power Network, U.S. Department of Energy EREN, www.eren.doe.gov/greenpower, October 5, 1998; State Renewable Energy News, Volume 6, No.1, Winter 1997, NARUC Subcommittee on Renewable Energy; Green Power Newsletter, Number 6, March 1998, The Regulatory Assistance Project, www.rapmaine.org; Colorado Wind Power Buyers, Land and Water Fund of the Rockies, September 1998; Colorado Solar Energy Industries Association, www.coseia.org/rebate.html, August 1998; Renewable Energy Sourcebook: A Primer For Action, Public Citizen, www.citizen.org/CMEP/renewables, June 1998; Green Power Notes, Center for Energy Efficiency and Renewable Technologies (CEERT), Center for resources Solutions (CRT), and Renewable Energy Marketing Board (REMB), www.cleanpower.org and www.green-e.org, June 1998; The States and Global Climate Change: Adopted and Proposed Initiatives, Submitted by The Center for Policy Alternatives, prepared by The Harrison Institute for Public Law, 1997; State and Local Legislative and/or Administrative Actions Having Direct or Incidental Effects on Greenhouse Gas Emissions, Center for Global Change, April 1992; Database of State Incentives for Renewable Energy, North Carolina Solar Center and Interstate Renewable Energy Council (IREC), www-solar.mck.ncsu.edu, May 1998; Government Actions on Climate Change in the Metropolitan NY/NJ/CT Region, Regional Plan Association, March 1998;

³ The Source for Renewable Energy, <http://www.sourceguides.com/energy/businesses>, October 1998.

⁴ U.S. Communities Acting to Protect the Climate: A report on the Achievements of ICLEI's Cities for Climate Protection - U.S., International Council for Local Environmental Initiatives, November 1997; EPA Program Managers as of November 1997. For further information, please see www.epa.gov/globalwarming.

 \$472 million will be saved by Pennsylvania companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.

More ENERGY STAR Facts

- Pennsylvania is home to 339 companies and public entities participating in ENERGY STAR partnerships.
- Over 467 million square feet of Pennsylvania building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 2920 times the size of Three Rivers Stadium.
- 14 ENERGY STAR-Labeled Product manufacturers are located in Pennsylvania.
- Investments already made through the ENERGY STAR program in Pennsylvania will prevent 15 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 2 million acres of trees — an area 7630 times the size of the University of Pennsylvania.
- Nitrogen oxide (NO_x) emissions will be reduced by 30 million pounds and sulfur dioxide (SO₂) by 108 million pounds due to existing ENERGY STAR investments in Pennsylvania.

Highlights

- St. Joseph's Hospital received the Green Lights Healthcare Partner of the Year Award in 1998.
- Elks Club of State College received the Green Lights Non-profit Partner of the Year Award and WESCO Distribution, Inc. received the Green Lights Lighting Distributor Ally of the Year Award in 1997.
- The following Green Lights Partner of the Year Award were received in 1996:
 - USX Corporation and Westinghouse Electric Corporation, Large Corporation
 - City of Philadelphia, City Government
 - Whitehill Lighting & Supplies, Inc., Lighting Distributor Ally of the Year
- Peirce-Phelps received the ENERGY STAR HVAC Certificate of Distinction in 1996.
- Lima Memorial Hospital received the Green Lights Hospital Partner of the Year Award in 1995.

Market Potential

- Pennsylvania has 3.5 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$1.4 billion would be saved annually
 - The following emissions would be prevented each year:
 - 34 billion pounds of CO₂
 - 92 million pounds of NO_x
 - 296 million pounds of SO₂

PENNSYLVANIA

ENERGY STAR Participants in Pennsylvania

1st Citizens National Bank

ALCOA

AMP Incorporated

ANESCO

AOK Body & Glass Co.

Ace Beauty Salon

Advanced Environmental Recycling

Corp.

Advanced Technical Systems

Aetna Felt Corporation

Air Products & Chemicals, Inc.

Albert Einstein Medical Center

Allegheny Health Education

Research Foundation

Allegheny University Hospital

Graduate

Allegheny University Hospitals

Allegheny University Hospital Pittsb

Allegheny University Hospitals

Allegheny Valley

Allegheny University Hospitals,

Bucks County

Allegheny University Hospitals,

Center City

Allegheny University Hospitals,

Elkins Park

Allegheny University Hospitals, St.

Christopher's Hospital

Allegheny University Hospitals-

East Falls

Allegheny County, Pennsylvania

Allen Publishing

City of Allentown, Pennsylvania

Altoona Hospital

Altoona School of Commerce

American Auto-Matrix Inc.

American Institute of Architects,

Philadelphia

Angelo Brothers

Aramark, World Headquarters

Aristech Chemical Corp

Armstrong Facilities Solutions, Inc.

Automatic Control Systems, Inc

Avtech, Inc.

Bacharach Incorporated

Barney Roth Co

Beaver College

Bell Atlantic

Belmont Center for Comprehensive

Treatment

Berks County Chamber

Bosco's Department Store

Bryn Mawr Hospital

Bucknell University

Bucks County, Pennsylvania

Burnham Corporation

C.W. Thomas Incorporated

CIGNA Corporation, Corporate

Real Estate Div.

CMB Associates, Inc.

CTEC Corporation

CW Matthews & Associates

Carnegie Mellon University

Carson Valley School

Centocor Inc

Charming Shoppes, Inc.

Chartiers Valley School District

County of Chester

Chestnut Hill Hospital

Child Evangelism Outreach

Clarion University of Pennsylvania

Clean Air Council

Colonial School District

Community College of Philadelphia

Community Light & Sound Inc.

Community Medical Center,

Scranton

Conserve Electric Company, Inc

CoreStates Financial Corporation

Corporate Energy Management

Systems, Inc.

Crown Boiler Company

Crown Cork & Seal Co., Inc.,

Machinery Dvsn

Crown Cork and Seal Worldwide

Headquarters

Cyntod Company

Days Inn Penn State

Delaware Valley Utility Advisors

County of Delaware, Pennsylvania

Design for Living

Dr. Rae Baum PhD & Associates

Drexel University

Duquesne University

Dynamic Concepts, Inc

E-Pak Technology Inc.

E-Finity Energy, LLC

Eagan and Associates Architects

The Electrical Assn of Philadelphia

Elks Club of State College

Energy Conservation Development

Corporation

Energy User News (Chilton

Publications)

Evangelical Environmental

Network

Expense Audit & Consulting

Company, Inc.

Fairmount East Apartments

Fairview School District

Farmers & Merchants Trust

Company

Forbes Regional Hospital

Friends Center Corporation

GGG Information Services

Gannon University

Geisinger Medical Center

General Products & Supply, Inc.

Goodwill Industries of Central PA,

Inc.

Graphic Art Association

Greater Exodus Baptist Church

Greater Philadelphia Chamber of

Commerce

Greater Philadelphia Hotel

Engineers Association

Greene County Memorial Hospital

Gwynedd-Mercy College

Hanover General Hospital

Harrisburg Area Community

College

Harrisburg Hospital

Hetherington Industries, Inc.

Highland Plaza Office Building

Historic Bartrams Garden

Hite Company, The

Hitech Corporation

Holy Family Convent/Infirmary

Hospital Association of

Pennsylvania

Hospital Council of Western

Pennsylvania

Hospital Engineers of Southwestern

PA

Hospital Shared Services

IKEA Property, Inc.

Industrial Scientific Corporation

Indiana University of Pennsylvania

Inst for Coop in Environmental

Management

Int'l Brotherhood of Elec Workers

Local Union #98

International Technology

Corporation

Interstate Hotels Corporation

Island Sports Center

Isolite Corporation

JC Blair Memorial Hospital

Javan & Walter Inc.

Johnson Controls, PA, WV, NJ

Juniata College

Kilowatt Saver, Inc.

Kutztown University

Lenora'S

Lawrence County, Pennsylvania

Lehigh University

Lima Memorial Hospital

Lock Haven University of

Pennsylvania

Lumax Industries Inc

Lutron Electronics Inc.

Marian Community Hospital

Marian Manor, Inc.

Markline Industries Incorporated

Mercy Fitzgerald Medical Center

(PA)

Mercy Hospital (Wilkes-Barre)

Mercy Hospital of Pittsburgh

Methodist Hospital (PA)

Meyer Electrical Supply Co

Mid Atlantic Energy Concepts

Incorporated

Mid Atlantic Lighting

Miller Lighting & Energy Inc.

Miller Lighting Company

Miners Memorial Medical Center

Modern Woman

Montclair Distributing

Moses Taylor Hospital

Most Rehabilitation Hospital

NRG Lighting Inc.

National Lighting Maintenance

Supply Co

Natures Place, Inc.

Nifty Fiftys

Norristown Area School District

Norshel, Inc.

North Penn Convalescent

North Philadelphia Health System

OMara Industries

OmniComp, Inc.

Optimal Technologies

Optimum Utility Systems

PPG Industries, Inc./General Office

PSG Limited

Paoli Memorial Hospital,

Pennsylvania

Paul Rabinowitz Glass Company

Pearl Pressman Liberty

Communications Grp

Peerless Heater Company

Pegasus Associates

Peirce-Phelps

Penn Small Business Dev Ctr

Pennsylvania Association of School

Business Officials

Pennsylvania Blue Shield

Pennsylvania Chamber of Business

and Industry

Pennsylvania Gas Association

Pennsylvania Hospital

Pennsylvania State University Main

Campus

Commonwealth of Pennsylvania

Philadelphia Newspapers Inc.

Philadelphia Water Department

The City of Philadelphia,

Pennsylvania

Phoenixville Hospital

Pine Run Community

The City of Pittsburgh,

Pennsylvania

Pocono Environmental Education

Center

Polestar Plastics

Powell Electronics

Powercon, Inc.

Preferred Home Health Care Corp

Program Employing People

Prolite Lighting & Sign

Maintenance

Quakertown Community School

District

Queen City Electric Supply

RLP Consulting

RMI Inc.

Reliance Standard Life Insurance

Rite Aid Corporation

Rose Technology Group, Inc.

Roselight

Rumsey Electric Company

Sir Speedy Printing

SMG

SRC Systems Incorporated

Saint Francis College at Loretto

St. Joseph Hospital (PA)

Saint Vincent College

Sea Change, Inc.

Shear Visions Inc.

Simkar Corporation

South Hills Health System

Springfield Hospital

Springfield School District

Sun Company Inc.

Superior Tube Company

Susquehanna Pfaltzgraff Company

Terry's Treasures

Taylor Hospital

Temple University

The Engraver

Thiel College

Thomas Jefferson University

Tri-State Light & Energy, Inc.

Tristar Lighting Co.

UNISYS Corporation

Naval Air Station (DOD), Willow

Grove

Pennsylvania Army National Guard

USX/US Steel Group

Uniontown Hospital

University of Pennsylvania - Main

Campus

University of Pittsburgh

University of Pittsburgh Medical

Center

University of the Arts at

Philadelphia

Upper Merion Area School District

Villanova University

WESCO Distribution-Headquarters

Division

Waterford Mortgage Corporation

West Chester University

The West Company

Westinghouse Electric Corporation

Wharton School (University of

Pennsylvania)

Whitehill Lighting & Supplies, Inc.

Wilkes University

YMCA of Philadelphia

York Foundation

York International Corporation

Yorklite Electronics, Inc.

Examples of Pennsylvania Partners Saving Money and Helping the Environment

St. Joseph's Hospital, Lancaster

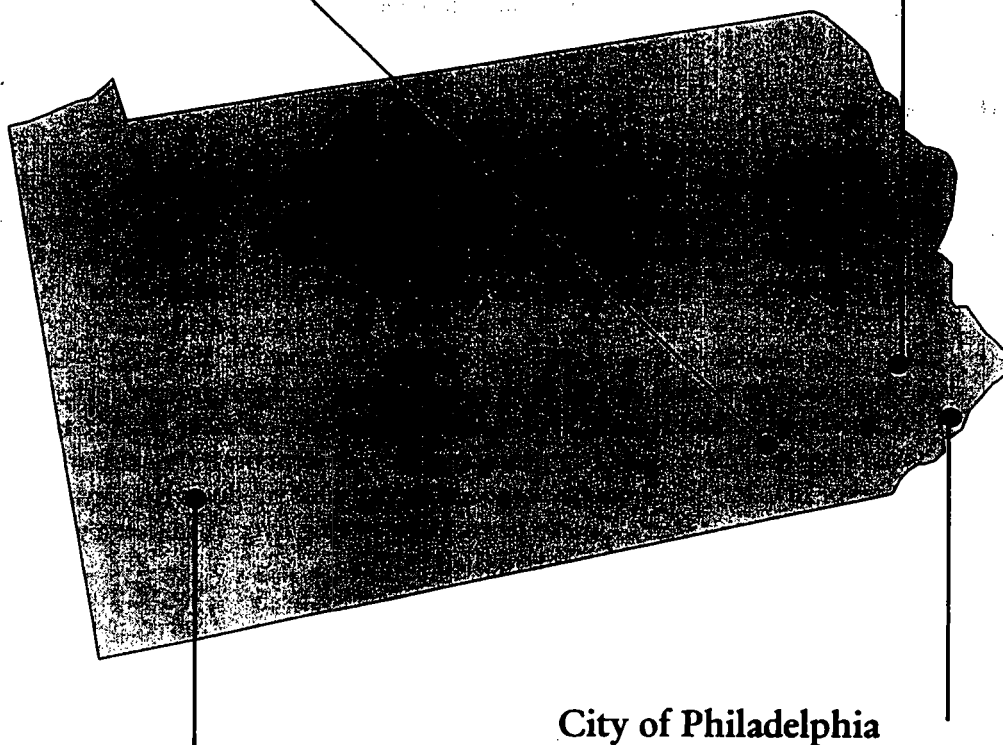
"[Energy efficiency] is definitely a win-win project. We're being good stewards of the environment, which is part of our heritage, and we're saving money at the same time."

— Richard Armstrong, Director of Engineering

- Saving \$175,000 in annual energy costs
- Upgraded lighting for 492,000 sq. ft.
- Reducing energy use by 2.9 million kWh annually
- Preventing 6 million pounds of CO₂ annually

Quakertown Community School District

- Saving \$78,000 in annual energy costs
- Upgraded 495,000 sq. ft.
- Reducing energy use by 1 million kWh annually
- Preventing 1.8 million pounds of CO₂ annually



USX/US Steel, Pittsburgh

"[It just makes sense [to be energy-efficient]."

— Tim Briney, Green Lights Coordinator

- Saving \$3.5 million in annual energy costs
- Preventing 158 million pounds of CO₂ annually
- Produced a video on its energy-efficient methods

City of Philadelphia

- Saving \$240,000 in annual energy costs
- Upgraded lighting for 5.6 million sq. ft.
- Reducing energy use by 2.6 million kWh annually
- Preventing 5.2 million pounds of CO₂ annually
- Purchasing energy-efficient office equipment and installing LED traffic signals

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$3.5 billion and prevent 78 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3000 participants, representing close to one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. Consumers are now saving over \$1 billion a year by bringing ENERGY STAR products into their homes.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Pennsylvania

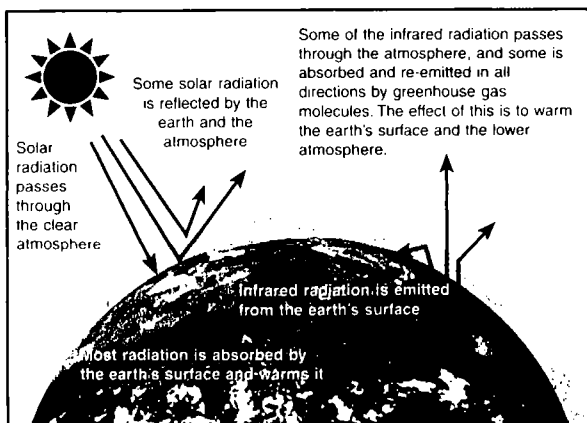
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, common air pollutants, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally.

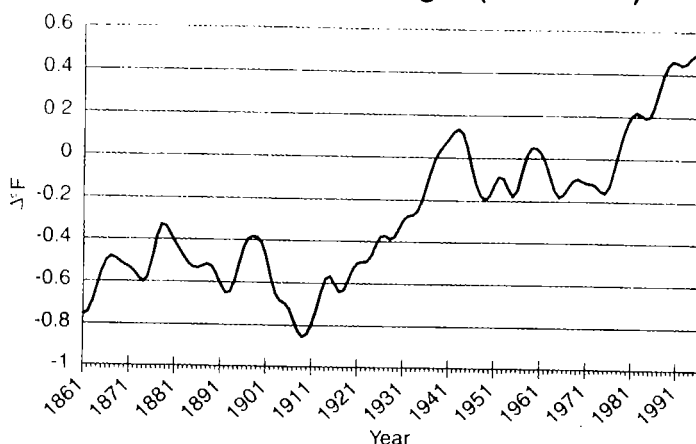
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that *“the balance of evidence suggests a discernible human influence on global climate.”*

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as

well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

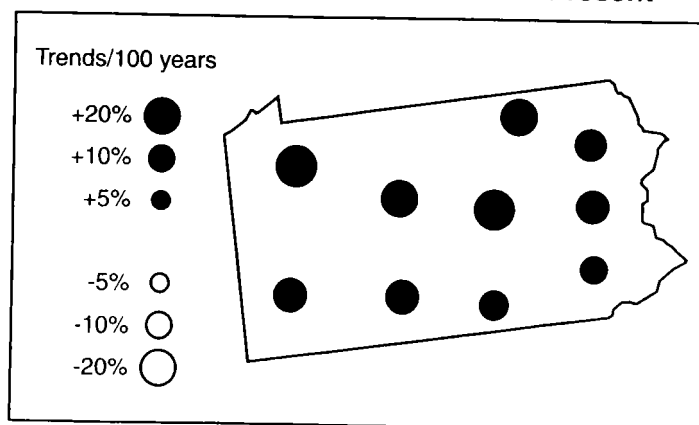
Over the last century, the average temperature in Harrisburg, Pennsylvania, has increased 1.2°F, and precipitation has increased by up to 20% in many parts of the state.

Over the next century, climate in Pennsylvania may change even more. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Pennsylvania could increase by about 4°F (with a range of 2-9°F), slightly less in summer and fall, and slightly more in winter and spring. Precipitation is estimated to increase by about 10% in spring, by about 20% in winter and summer, and by as much as 50% in fall. Other climate models may show different seasonal changes in rainfall. The amount of precipitation on extreme wet or snowy days is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. Although it is not clear how severe storms would change, an increase in the frequency and intensity of summer thunderstorms is possible.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Pennsylvania, with its irregular, intense heat waves, could be especially susceptible.

In Philadelphia, one study projects that by 2050 heat-related deaths during a typical summer could increase 90%, from close to 130 heat-related deaths per summer to over 240 (although increased air conditioning use may not have been fully accounted for). Similar but smaller increases have been projected for Pittsburgh, from about 40 heat-related deaths to 60, or a 50% increase. Winter-related deaths could drop from 85 in Philadelphia per winter to about 35 if winter temperatures warm. In Pittsburgh, winter-related deaths are expected to change very little. The elderly, particularly those living alone, are at greatest risk.

Climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbon emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

A preliminary modeling study of the Midwest, which included the area around Pittsburgh, found that a 4°F warming, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by as much as 8%. Currently, ground-level ozone concentrations exceed national ozone health standards in several areas throughout the state, with the Philadelphia area classified as a “severe” nonattainment area for ozone. Ground-level ozone has been shown to aggravate respiratory illnesses such as asthma, reduce existing lung function, and induce respiratory inflammation. In addition, ambient ozone reduces crop yields and impairs ecosystem health.

Warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue (“break bone”) fever. Mosquitos flourish in some areas found Pennsylvania. Some can carry malaria, while others can carry encephalitis, which can be lethal or cause neurological damage. Incidents of Lyme disease, which is carried by ticks, have increased in the Northeast. If conditions become warmer

and wetter, mosquito and tick populations could increase in Pennsylvania, thereby increasing the risk of transmission of these diseases.

Water Resources

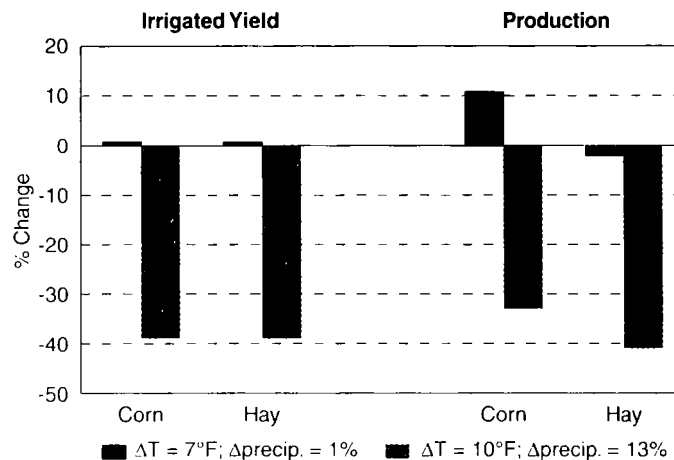
Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. If streamflow and lake levels drop, groundwater also could be reduced. In addition, more intense precipitation could increase flooding.

Pennsylvania’s Susquehanna River drains much of the eastern two-thirds of the state, and the Allegheny and the upper Ohio rivers drain most of the western third. A warmer climate would lead to earlier spring snowmelt, and could result in higher streamflows in winter and spring and lower streamflows in summer and fall. However, changes in rainfall also could have significant effects on streamflow and runoff and, if summer precipitation falls, could affect adversely downstream uses such as navigation on the Ohio River. Increased precipitation in winter or summer could offset losses from increased evaporation, but also could lead to increased flood risk. Some of the most intense flooding on record in the United States has occurred in Pennsylvania.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

In Pennsylvania, agriculture is a \$3.8 billion annual industry, two-thirds of which comes from livestock, most of which is dairy. About 6% of the crop acreage is irrigated. The major crops in the state are corn and hay. Climate change could change crop yields very little or by as much as 39%, leading to changes in acres farmed and production. For example, hay yields could rise while production falls because of a decrease in hay acres farmed.

Forests

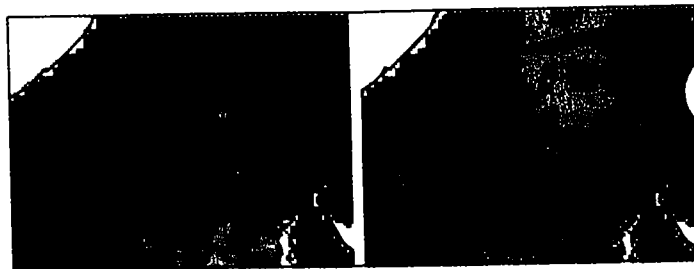
Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic range, and health and productivity. If conditions also become drier, the current range of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to warmer conditions, such as oaks and pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Pennsylvania could change little or decline by as much as 15-25%. However, the types of trees dominating Pennsylvania forests and woodlands are likely to change. The maple, beech, and birch forests found in northern Pennsylvania would retreat northward. Forest areas would become dominated by oak, ash, hickory, and pine, and the brilliant autumn foliage associated with maples would be diminished. In areas where richer soils are prevalent, southern pines could increase their range and density,

Changes In Forest Cover

Current

+10°F, +13% Precipitation



■ Conifer Forest
■ Broadleaf Forest
■ Savanna/Woodland

Source: VEMAP Participants (1995); Neilson (1995)

and in areas with poorer soils, which are more common in Pennsylvania's forests, scrub oaks of little commercial value (e.g., post oak and blackjack oak) could increase their range. As a result, the character of forests in Pennsylvania may change.

Ecosystems

Ecosystems in Pennsylvania consist of forests, woodlands, wetlands, peatland, and riparian habitats. The Two Mile Run wetlands in the Pocono Mountains are the largest undisturbed peatland ecosystem in Pennsylvania. This is also the site of the largest and healthiest native spruce forest in Pennsylvania. The peatlands are an important habitat for black bears, which use them for denning and feeding. Snowshoe hare, osprey, beaver, river otter, and waterfowl also live in the Two Mile Run wetlands area. Climate change could alter the range and location of these habitats, and fragmented land use patterns could impede migration of plants and animals.

Climate change could adversely affect ecosystems such as the Erie National Wildlife Refuge and French Creek, which flows for 117 miles through northwestern Pennsylvania. This area provides habitat for approximately 70 species of fish and 25 species of freshwater mussels. Many of the aquatic species in French Creek (for example, the clubshell mussel) are already endangered. The refuge system also provides important habitat for birds, including the threatened bald eagle.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.





Climate Govs <cgoyette@ICFCONSULTING.COM>

02/07/2000 08:50:19 AM

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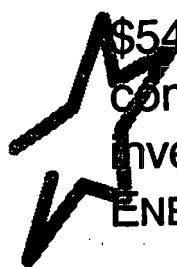
Subject: Pennsylvania Buys Green Power

***Pennsylvania Buys Green Power

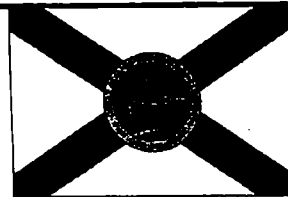
Pennsylvania has become the first state in the nation to have its government begin receiving "green" electricity from GreenMountain.com. The Pennsylvania Department of General Services (DGS) awarded a contract to Green Mountain to supply state government with renewable electricity. Green Mountain will supply electricity to more than half a dozen government accounts representing 5 percent of the DGS power purchase for 2000.

Pennsylvania agencies receiving power from Green Mountain include the Capitol Complex buildings in Harrisburg, state office buildings in Pittsburgh, Scranton, and Reading, the Pennsylvania Department of Corrections, and Pennsylvania's 14 universities. GreenMountain.com's Mid-Atlantic region president David Breitmayer says, "The Pennsylvania government contract demonstrates that cleaner and renewable electricity is competitive, reliable and a viable form of energy supply."

To learn about climate change, check out EPA's website at www.epa.gov/globalwarming. The site has a wealth of information on the climate system; greenhouse gas emissions; impacts of climate change; and actions that can be taken at the national, state, local, business, and individual levels.



\$542 million will be saved by Florida companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



More ENERGY STAR Facts

- Florida is home to 201 companies and public entities participating in ENERGY STAR partnerships.
- Nearly 295 million square feet of Florida building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 14,000 times the size of the Miami Arena.
- 13 ENERGY STAR-Labeled Product manufacturers are located in Florida.
- Investments already made through the ENERGY STAR program in Florida will prevent over 21 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 3 million acres of trees — an area 2 times the size of the Everglades.
- Nitrogen oxide (NO_x) emissions will be reduced by 51 million pounds and sulfur dioxide (SO₂) by 115 million pounds due to existing ENERGY STAR investments in Florida.

Highlights

- Broward County received the ENERGY STAR Buildings Government Award in 1999.
- Florida Solar Energy Center and Florida HERO received the ENERGY STAR Homes State or Local Government Agency of the Year Award in 1999.
- Gainesville Regional Utilities received the ENERGY STAR Homes Utility Ally Award and Palm Harbor Homes received the Manufactured Home Builder Award in 1998.
- John A. Clark, Abacoa Development Company and Disney Development Corporation received ENERGY STAR Homes Certificates of Distinction in 1996.
- Addison Products received the ENERGY STAR Residential Heating and Cooling Small Manufacturer Award in 1997 and 1996.

Market Potential

- Florida has 4.2 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$1.5 billion would be saved annually
 - The following emissions would be prevented each year:
 - 45 billion pounds of CO₂
 - 140 million pounds of NO_x
 - 374 million pounds of SO₂

FLORIDA

ENERGY STAR Participants in Florida

ABB Optical
 ACE Electrical Service, Inc.
 Active Electric Supply
 Addison Products Company, Tampa
 Address-o-lite
 Advanced Energy Management Corporation
 Advanced Energy Systems, Inc.
 Advanced Lighting, Incorporated
 Agriflora Corporation
 Amelia Island Plantation
 American Aluminum Ent.
 Anderson Plumbing & Heating Inc.
 Arizona Commercial Port Services, Florida
 Association of Energy Services Professionals
 BAYSIDE
 Bankers Finance Group
 Barry University
 Beckman Electric Company, Inc.
 Blockbuster Entertainment Corporation
 City of Boca Raton, Florida
 Brevard Community College
 Brevard County School System
 Broward Community College
 Broward County, Florida
 Brownlee Lighting
 Burger King Corporation
 Carrabelle IGA
 CMAC of America Incorporated
 CMS Mechanical Service Company
 Cape Canaveral Marine Services, Inc.
 Car Doctor, Inc.
 Catalina Lighting
 Celotex Corporation, The
 Center For Applied Engineering, Inc.
 Central Florida Community College
 Champion Computer Corporation
 Chem Polymer
 Columbia County School District, Florida
 Comprehensive Energy Services, Inc.
 Croy Environmental Services
 Custom Biologicals Inc.
 David Rich's IGA
 Dade County, Florida
 Data Net Corporation
 Datamax Corporation
 Daytona Beach Community College
 ECR Technologies, Inc.
 Exceltech
 Eckerd Corporation
 Energy Conservation Allies, Inc.
 Energy Planning Associates
 Esatech C.A.
 Etus Inc.
 Eva-Tone
 First International Asset Management
 Florida Department of Community Affairs
 Florida Dept. of Environmental Protection
 Florida Heat Pump Environmental Equipment
 Florida Hospital Association
 Florida Institute of Government
 Florida International University
 Florida Lighting
 Florida Power Corporation
 Florida Spill Response Corp.
 The State of Florida
 Food & Beverage Manager
 Fudpuckers of Fort Walton Beach, Inc.

G Pierce Wood Memorial Hospital
 GeoModel Inc.
 Glace Energy, Inc.
 Gladstones Grilled Chicken
 Glaring, Jackson
 Global Energy & Environmental Research, Inc.
 Grand Court
 Greater Jacksonville Area Hospital Council
 Greater Miami Chamber of Commerce
 Gulf Power Company
 Guyco Corporation
 Harris Corporation
 Harris Manufacturing, Inc.
 Hatch Transformer, Inc.
 Heat Pipe Technology
 Hi Ho Silver
 Hillsborough County, Florida
 Hollywood Woodwork
 Horizontal Tech Inc.
 IGA Food Villa
 Incon Industries
 Incon Lighting Incorporated
 Industrial Building Services
 Integrated Building Technologies, Inc.
 International Academy of Merchandising and Design
 International Food Service Executives Assoc.
 Jacobson's
 Jordan IGA Foodliner
 Jugs Galore
 Johnson Controls World Services, Inc.
 Keith Williams
 KVAR Energy Savings, Inc.
 King Lighting Supply
 Kolar Management Inc.
 LTI International, Inc.
 La Crane, Inc.
 Laser Lighting & Electrical Supply, Inc.
 Lee Memorial Health System
 Lee County, Florida
 Leon County School Board
 Leon County, Florida
 Lighting Solutions
 Lightscience Corporation
 Lockheed Martin SLRC
 Lumen-Tronics
 Magnaray International
 Marketing Corporation
 Martin County School District
 City of Miami Beach, Florida
 Miami Museum of Science and Space
 Monolithic Structures Corporation
 Mor-Lite of North America
 Munroe Regional Medical Center
 Munters Corporation
 Nat Assn of Power Engineers Met Miami Ch #4
 Nature Based Hospitality Group
 Neighborhood Service Center
 New Atlantic Beach Apartments
 North American Lighting Services, Inc.
 North Shore Medical Center, Inc.
 Okaloosa-Walton Community College
 Okeechobee School Board
 Online Technology Exchange, Inc.
 Orange County, Florida
 Orlando Utilities Commission
 Osceola County School District

Oxford Properties Florida
 Palm Beach County School Board
 County of Palm Beach, Florida
 Parkson Corporation
 The Plaid Lab
 Planet Earth Environmental Services
 Polk Community College
 Polk County, Florida
 Professional Lighting, Inc.
 Quarry Systems, Inc.
 Ramco Trading Corporation
 Real-Time Laboratories, Inc.
 Red Smith
 Reflect-A-Light, Inc.
 S.W. Red Smith
 Scott's IGA Foodliner
 St. Luke's Hospital (FL)
 Sara International Incorporated
 Sarasota County, FL, School Board
 Sarasota Memorial Hospital
 Sarwat Corp.
 Save-A-Watt, Inc.
 School Board of Hernando County
 Sebastian River Area Chamber of Commerce
 Siemens Information and Communications Networks, Inc.
 Snellgroves Restaurant
 Solar Outdoor Lighting
 Space Coast Energy Services Inc.
 Spires Inc.
 Sprint Southern Operations
 Subway Sandwich #3251 Arcadia, FL
 Subway of B.W.B.
 Subway of Beal
 Subway of Destin
 Subway of Egla Pkwy
 Subway of Mary Esther
 Subway of Shalimar
 Systematix, Inc.
 The City of Tallahassee, Florida
 Tampa Bay Estuary Program
 Tampa Bay Trane
 Tampa Electric
 Tampa General Hospital
 Tech-Vest Incorporated
 The Hunter Lighting Group
 Tropical Lighting
 Tubular Skylight, Inc.
 US Fiber Inc.
 Florida Army National Guard
 JN Ding Darling National Wildlife Refuge
 United Energy Associates
 Universal Lighting Services
 Universal Studios Florida
 University of Central Florida
 University of Florida
 University of Miami
 University of South Florida
 University of West Florida at Pensacola
 Vision Impact Corporation
 W. E. S. Inc.
 WR Grace & Company
 Walt Disney World Company
 Wendo Corporation
 Winning Edge Products
 Winter Haven Chamber of Commerce
 Zeller International

Examples of Florida Partners Saving Money and Helping the Environment

Casual Creations, Inc., Mary Esther

"In our constant search to improve lighting quality, which is essential in interior design, today's new lighting technologies provide improved lighting quality and energy savings as an added benefit."

- Fred Cochran, Owner

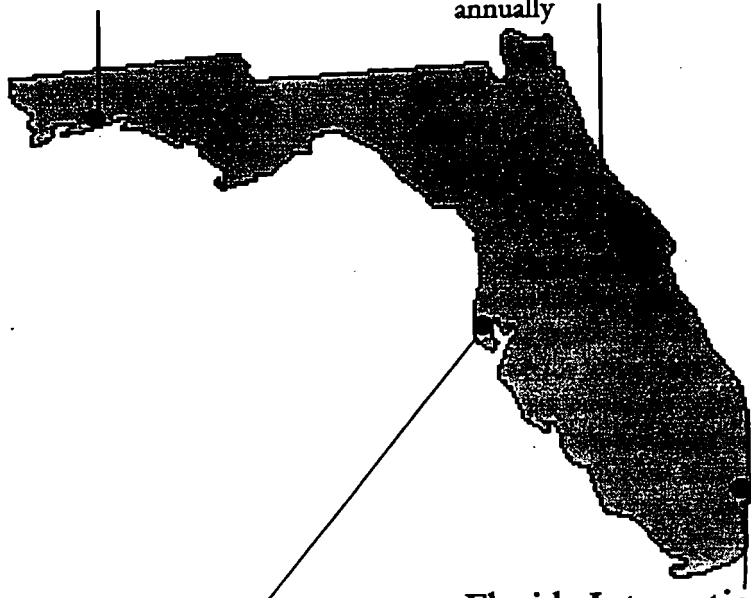
- Saving \$5,000 in annual energy costs
- Installed energy-efficient lighting and occupancy sensors
- Preventing 92,000 pounds of CO₂ annually

Walt Disney World, Orlando

"The idea of reducing costs, improving conditions in facilities, minimizing pollution, and gaining positive public recognition, all at a profitable return, is truly a win-win partnership."

- Kym Murphy, Corporate VP,
Environmental Policy

- Saving \$858,000 in annual energy costs
- Upgraded lighting in more than 8 million sq. ft.
- Reducing energy use by 17.6 million kWh annually, enough to power Disney's Animal Kingdom
- Preventing 30 million pounds of CO₂ annually



Eckerd Corporation, Largo

- Saving 8 million in annual energy costs
- Upgraded lighting in 31 million sq. ft.
- Reducing energy use by 129 million kWh annually
- Preventing 269 million pounds of CO₂ annually
- Exploring more energy-efficient HVAC systems

Florida International University, Miami

"Enrollment is increasing 6-8 percent each year and new buildings are being constructed but costs are not increasing."

- Juan Carlos Abril

- Saving \$219,000 in annual energy costs
- Reducing energy use by 3.1 million kWh annually
- Preventing 6.7 million pounds of CO₂ annually
- Established an Energy Conservation Assistance Program which offers local small businesses free energy surveys and sets up audits and loans for energy-efficiency upgrades

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$3.5 billion and prevent 78 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3000 participants, representing close to one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. Consumers are now saving over \$1 billion a year by bringing ENERGY STAR products into their homes.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Florida

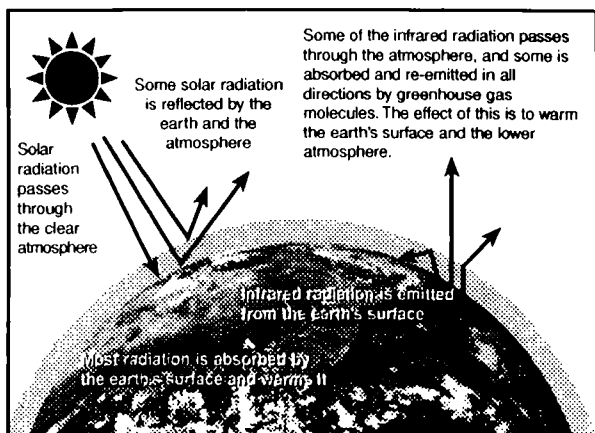
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

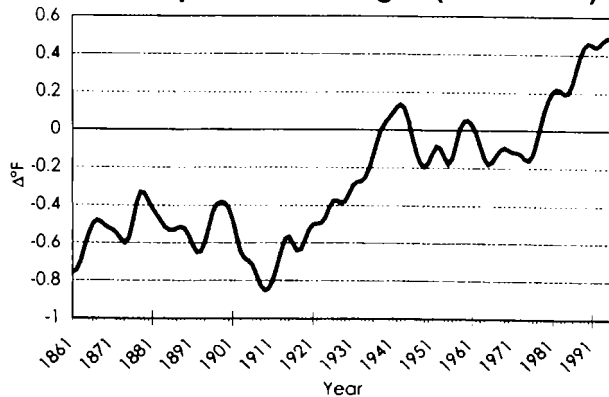
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F since the late 19th century. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere's heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, average temperatures have increased in Florida. At Ocala, the 1892-1921 average temperature was almost 67°F; the 1966-1995 average temperature was over 69°F. Precipitation over the last hundred years has decreased in the Keys and parts of south Florida, and increased in central Florida and the panhandle.

Over the next century, Florida's climate may change even more. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that has accounted for both greenhouse gases and aerosols, by 2100 temperatures in Florida could increase by 3-4°F (with a range of 1-6°F) in spring, summer, and fall, and by somewhat less in winter. Little change is projected for precipitation.

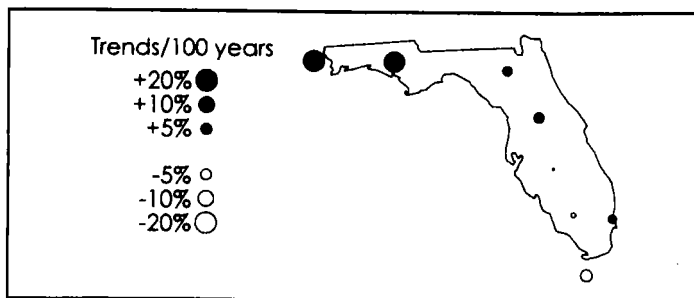
The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms such as hurricanes would change.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Recent scientific work suggests that 28 people die every year in Tampa from heat-related causes during summer. Even if people adjust to climate change, a 3°F warming could more than double this figure; as many as 68 additional heat-related deaths could occur every year in Tampa during the summer. The elderly, particularly those living alone, are at greatest risk.

There is concern that climate change could increase concentrations of ground-level ozone. For example, specific weather conditions — strong sunlight, stable air masses — tend to increase urban ozone levels. While Florida is in compliance with current air quality standards, increased temperatures could make remaining in compliance more difficult. Ground-level ozone has been shown to aggravate existing respiratory illnesses such as asthma, reduce lung function, and induce respiratory inflammation. In addition, ambient ozone reduces agricultural crop yields and impairs ecosystem health.

Changing climate conditions also may affect human health through impacts on terrestrial and marine ecosystems. In particular, warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, increasing the potential for transmission of diseases such as malaria and dengue (“break bone”) fever. Although dengue fever is currently uncommon in the United States, conditions already exist in Florida that make it vulnerable to the disease. Warmer temperatures resulting from climate change could increase this risk.

Finally, sea surface warming and sea level rise could increase health threats from marine-borne illnesses and shellfish poisoning in Florida. Warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. These blooms damage habitat and shellfish nurseries, can be toxic to humans, and can carry bacteria like those causing cholera. In turn, algal blooms potentially can lead to higher incidence of water-borne cholera and shellfish poisoning. Acute poisoning related to the consumption of contaminated fish and shellfish has been reported in Florida.

Coastal Areas

Global sea level rise is one of the most likely effects of global warming. Along much of the Florida coast, the sea level already is rising 7-9 inches per century. Because of local factors such as land subsidence and groundwater depletion, sea level rise will vary by location. For Florida, the sea level is likely to rise 18-20 inches by 2100. As sea level rises, coastal areas in Florida, particularly wetlands and lowlands along the Gulf and Atlantic coasts, could be inundated. Adverse impacts in these areas could include loss of land and structures, loss of wildlife habitat, accelerated coastal erosion, exacerbated flooding and increased vulnerability to storm damage, and increased salinity of rivers, bays, and aquifers, which would threaten supplies of fresh water.

Possible responses to sea level rise include building walls to hold back the sea, allowing the sea to advance and adapting to it, and raising the land (e.g., by replenishing beach sand and/or elevating houses and infrastructure). Each of these responses would be costly, either in out-of-pocket costs or in lost land and structures. For example, the cumulative cost of sand replenishment to protect Florida's coast from a 20-inch rise in sea level by 2100 is estimated at \$1.7-\$8.8 billion.

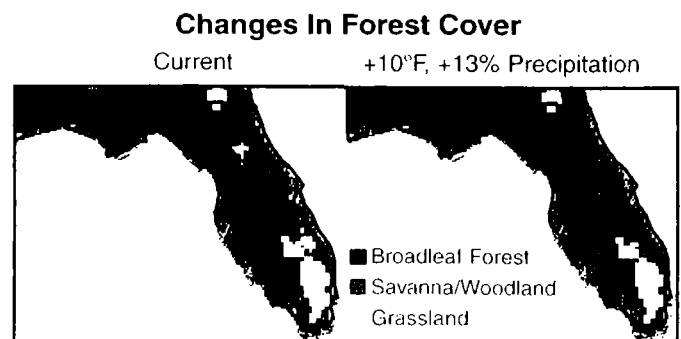
Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. Changes in tree species, geographic extent, and the health and productivity of forests could be expected with a warmer climate. If conditions also become drier, the current range of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to warmer conditions, such as tropical evergreens, would prevail over time. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

The mixed conifer/hardwood forests found in the northern and panhandle sections of Florida are likely to retreat northward. These forests eventually could give way to wet tropical forests such as tropical evergreen broadleaf forests and dry tropical savanna. These changes would be accompanied by a reduction in forest density. The dry tropical savanna of the Florida peninsula could become more of a seasonal tropical forest with a corresponding increase in forest density. The potential dieback of forests along the Gulf coast could adversely affect forest-based recreation and commercial timber.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels,



Source: VEMAP Participants (1995); Neilson (1995)

particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

A critical factor in Florida's development, especially in southern Florida, has been water. Although south Florida receives an annual average of 60 inches of rain, annual evaporation sometimes can exceed this amount. Rainfall variability from year to year is also high, resulting in periodic droughts and floods. Competing demands for water — for residences, agriculture, and the Everglades and other natural areas — are placing stresses on south Florida's water resources.

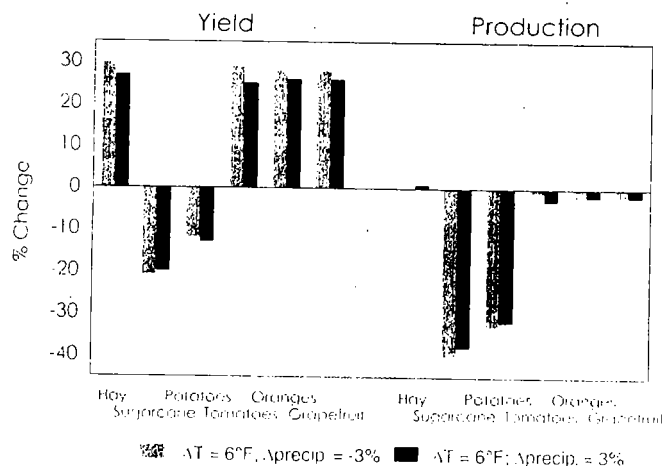
Higher temperatures increase evaporation, which could reduce water supplies, particularly in the summer. Saltwater intrusion from sea level rise also could threaten aquifers used for urban water supplies. These changes could further stress south Florida's water resources.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

Florida is one of the leading states in terms of cash revenue from farming, with irrigated cropland accounting for the high value of farm production. Yields of citrus fruits could decrease with warmer temperatures in the southernmost part of the state because of a lack of a sufficient dormant period. Changes in cotton and sorghum production are unclear — increasing CO₂ levels and rainfall would be likely to increase yields, but the shortened growing season brought on by increasing temperatures could result in plants producing fewer or smaller seeds and fruit, which would decrease yields. Increases in temperature (about 6°F) and rainfall (10%) are projected to reduce corn yields by 14%.

Unique Ecosystems: The Big Cypress Swamp, The Everglades, And The Keys

Southern Florida has national treasures in the Big Cypress Swamp, the Everglades, and the Keys. These three ecosystems are interlinked and have a common history. The Big Cypress Swamp is part of the broad, shallow river moving fresh water south into the Everglades. The Keys mark the last outposts of the Everglades lands. Once hummocks of higher vegetation set in a prehistoric swamp, they have struggled against the rising sea. Mangroves on their perimeters collect silt and organic material, building a barricade secure against all but the most severe hurricane winds and tides. In the Everglades and Big Cypress Swamp, there is a strong contrast between the seasons. From early spring well into autumn, they have ample rainfall, averaging 50 inches per year. Winter is a time of drought and fire, and saltwater penetrates farther inland.

Already stressed by water diversions, invading species of plants and animals, and the natural phenomena of drought, flood, and storms, these ecosystems will be stressed further by climate change. A 20-inch sea level rise would cause large losses of mangroves in southwest Florida. Increased salinity, resulting from rising saltwater into the Everglades from Florida Bay, also would damage freshwater ecosystems containing sawgrass and slough. Communities of wet prairie also would decline with the rise in sea level.

Climatic conditions in central Florida may become suitable for subtropical species such as Gumbo-limbo, now confined to subtropical hummocks in the southern part of the peninsula and the Keys. Theoretically, such species could move as far north as Gainesville and Jacksonville, but agricultural and urban development could preclude such migration.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.



\$705 million will be saved by Texas companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



TEXAS

More ENERGY STAR Facts

- Texas is home to 164 companies and public entities participating in ENERGY STAR partnerships.
- Over 465 million square feet of Texas building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 2450 times the size of the Alamodome.
- 16 ENERGY STAR-Labeled Product manufacturers are located in Texas.
- Investments already made through the ENERGY STAR program in Texas will prevent 16 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 2 million acres of trees — an area over 5300 times the size of the University of Texas-Austin.
- Nitrogen oxide (NO_x) emissions will be reduced by 49 million pounds and sulfur dioxide (SO₂) by 62 million pounds due to existing ENERGY STAR investments in Texas.

Highlights

- Compaq received the Green Lights Corporation Partner of the Year Award in 1998, the ENERGY STAR Office Equipment Computer Partner of the Year Award in 1997, and the ENERGY STAR Personal Computer Partner of the Year Award in 1996.
- Lighting Management Consultants, Inc. received the Green Lights Lighting Management Company Ally of the Year Award in 1997.
- Halliburton Company received the Green Lights Corporation Partner of the Year Award and University of Texas M.D. Anderson Cancer Center received the Green Lights Large Hospital Partner of the Year Award in 1996.
- Energy Wise Management Systems received an ENERGY STAR Homes Certificate of Distinction in 1996.
- Landmark buildings in Texas including the Rolex Building and LBJ Financial Center in Dallas and Harrington Place in Plano have expressed their commitment to being among the top 25 percent in energy performance nationally.

Market Potential

- Texas has 5.6 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$2.3 billion would be saved annually
 - The following emissions would be prevented each year:
 - 42 billion pounds of CO₂
 - 183 million pounds of NO_x
 - 171 million pounds of SO₂

ENERGY STAR Participants in Texas

3D International
4545 B...net...
ACR Engineering, Inc.
AW Mechanical
Ad... Inc.
Advanced Fixture...
Affiliated Companies Services Inc.
Alamo Community College District
American Light, Inc.
American Rockwell, Inc.
American Standard Tyler TX
Austin... Inc.
The City of Austin, Texas
B... Exploration
... College of Dentistry
Bristol Hotel Management
Corporation
Browning-Ferris Industries
Burk Burnett Independent School
District
CCR Lighting Technologies
CES/WAY International, Inc.
CEW Lighting Inc.
Compaq Computer Corporation
Carter and Burgess Incorporated
Club Corporation, International
College of the Mainland
Comal Independent School District
Command Data
Compaq Computer Corporation
Compass Management & Leasing, Inc.
- Dallas Region
Component Express Corp
Continental Airlines, Inc.
Control Systems International
Cooper Industries
Corpus Christi Independent School
District
Depriest Christian Center
Dallas Independent School District
Dell Computer Corporation
Dolphin Blue, Inc.
Dolphin Blue, Inc.
DuraLux Industries
EPA Region 6
Eanes Independent School District
El Paso County Community College
District
Elliot Electric Supply
EnerSource Capital, LLC
Energy Related Projects
Enron Property Company
Environmental Energy Group
Equator Corporation
Fab Subs, LTD
Facility Works
Family Clinic of Corsicana
Fina Incorporated
Fort Bend Independent School District
County of Fort Bend, Texas
The City of Georgetown, Texas
Utility
Good Shepherd Medical Center
Goodman Manufacturing
The City of Grapevine, Texas
Greater Dallas Chamber of Commerce
Green Hotels Association

Group Maintenance America Corp.
HE Butt Grocery Company
HOU-TRA International
Halliburton Company
Harris County, Texas, Facilities and
Property Management Dep
Harrison Industries, Inc.
Hines Interests Ltd P'ship: Columbia
Sq.
Houston Independent School District
The City of Houston, Texas
Houstonian, The
Humble Independent School District
Interstate Fitting Inc
IPC Corporation, Ltd.
Integrated Lighting & Energy
Company
International Cellulose Corp.
International Facility Management
Association
International Paper/Texarkana Mill
Inventec Electronics
J.D. Wilson Associate
JCPenney Company, Inc.
Johnstone Supplies
Kelly Air Force Base
L and R Aqua, Inc.
La Quinta Inns Inc.
Lamar University-Port Arthur
Landman
Lennox Industries Incorporated,
Richardson
Lighting Management Consultants
Lighting Solutions
Lighting Systems Upgrade
Littlefield Real Estate Company
Lone Star Steel
Lyondell Petrochemical
Marathon Oil Company
Marlin Environmental Products
Incorporated
Mary Kay, Inc.
Mature Net
McAllen Independent School District
McNeil Real Estate Management
Medina Valley Independent School
District
MetalOptics, Inc.
Metropolitan Transit Authority of
Houston
Micro-Bac International Inc
Microtherm, Inc.
Murata Business Systems
MyTech Corporation
Newmark Home Corp
Newpark Shipbuilding & Repair, Inc.
Northrop Grumman-Commercial
Aircraft Division/Vought Center
Omnidex, Inc. dba Omnifax
Oryx Energy Company Inc.
PAJ Inc.
PanEnergy
Pennzoil Company
Perfect Cycle Corporation
Pizza Inn Franchise SLS
PolarShield, LLC
Pottsboro Independent School District

Powell Electrical Manufacturing
Company
Power Lighting Products, Inc.
Power Savers, Inc.
Presbyterian Healthcare System
Pro-Tec-Tor Products and Services
Company
Quaker State Corporation
RadioShack, A Division of Tandy
Corporation
The Rice University Student
Association
The Rice University
River Run Bed and Breakfast Inn
Riviana Foods, Inc, Edison
Distribution Ctr
Rmax, Inc.
St. Mary's University
Shell Oil Company
Sierra Power Group Inc.
Smith Alarm Systems
Solar Kinetics
Southwest Texas State University
Spectrum of Light Youth March Earth
Day XXV
Spohn Health System
Stadium Subway Corp
Sysco Food Services of Houston
TDIndustries
Tarleton State University
Tascon, Inc.
TerraPro Property Management
Company
Texas Air Control Board
Texas Association of Business
Texas Building Energy Institute
Texas Department of Criminal Justice
Texas Department of Transportation,
Headquarters Austin
Texas Medical Center
Texas Natural Resources Conservation
Commission
Thermasave Building Systems L.L.C.
The Trane Company, Waco
Randolph Air Force Base
University of Texas Health Science
Ctr/Houston
The University of Texas M.D.
Anderson Cancer Center
University of Texas at San Antonio
Warren Electric Company
Wholesale Electric Supply Company
X-Tra Light Systems, Inc.
Xencom Systems, Inc.
Zapata County Independent School
District
Zurn Industries, Inc.

Examples of Texas Partners Saving Money and Helping the Environment

Chevron, Houston

"The Star Program has helped us save gas, increase profits, and improve steam efficiency."

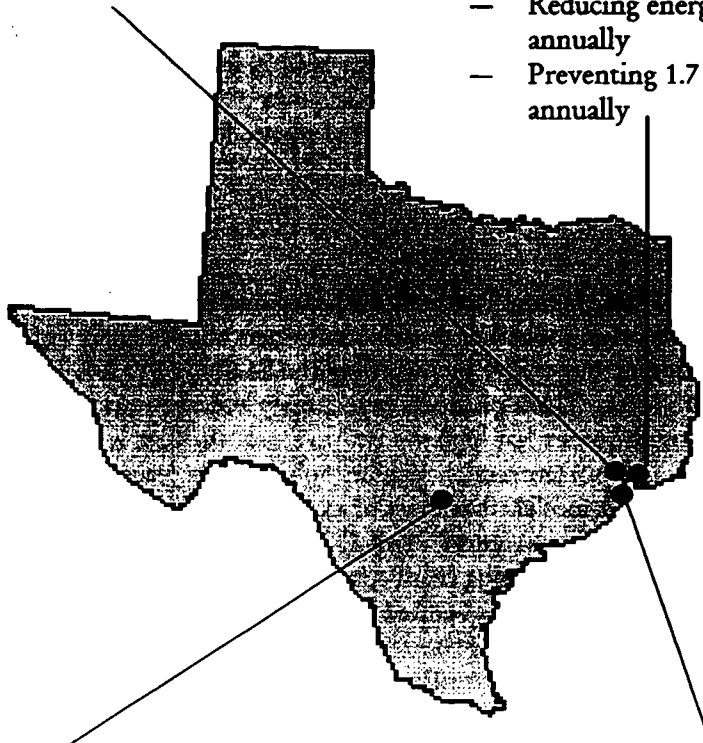
- Implemented several cost-effective methane reduction technologies and practices
- Prevented 7 billion cubic feet of methane since 1990, an amount equal to 6.3 billion pounds of CO₂ and worth over \$14 million

Compaq, Houston

"Reducing energy costs and conserving energy ties into our business strategy. Our energy savings provide lower rates and lower product prices."

— Steve Garner

- Saving \$43,000 in annual energy costs
- Upgraded lighting for 3 million sq. ft.
- Reducing energy use by 1 million kWh annually
- Preventing 1.7 million pounds of CO₂ annually



La Quinta Inns, San Antonio

- Saving \$1.2 million in annual energy costs
- Upgraded 8 million sq. ft.; committed to 6 million more
- Reducing energy use by 18 million kWh annually
- Preventing 21 million pounds of CO₂ annually

City of Houston

"The City of Houston recognizes the environmental and financial value of initiating a facility-wide energy efficiency program."

— Dewayne Huckabay, Director of Fleet and Environmental Management

- Saving \$335,000 in annual energy costs
- Completed lighting upgrades for 2 million sq. ft.; planning on 7 million more
- Reducing energy use by 5.2 million kWh annually
- Preventing 6.7 million pounds of CO₂ annually

EPA's ENERGY STAR Programs

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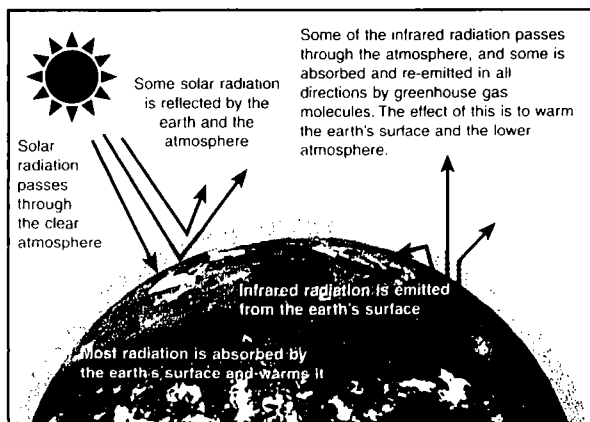
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Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, common air pollutants, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally.

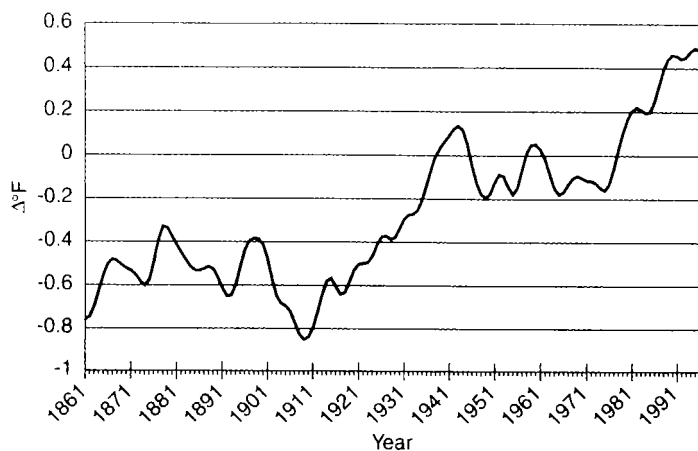
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen 4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. Scientists are reasonably confident about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some

extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average annual temperature in San Antonio, Texas, has decreased 0.5°F, and precipitation has decreased by up to 20% in some parts of the state.

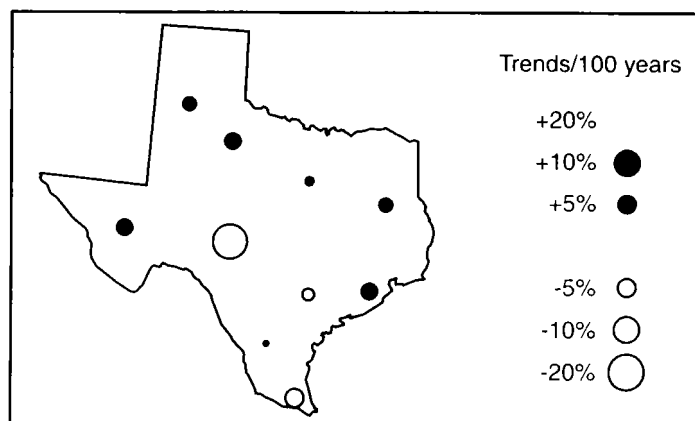
Over the next century, climate in Texas could experience additional changes. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Texas could increase by about 3°F in spring (with a range of 1-6°F) and about 4°F in other seasons (with a range of 1-9°F). Precipitation is estimated to decrease by 5-30% in winter and increase by about 10% in the other seasons. Increases in summer could be slightly larger (up to 30%) than in spring and fall. Other climate models may show different results. The amount of precipitation on extreme wet or snowy days in winter is likely to decrease, and the amount of precipitation on extreme wet days in summer is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. It is not clear how severe storms such as hurricanes would change.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Texas, with its intense heat waves, could be especially susceptible.

In Dallas, one study projects that by 2050 heat-related deaths during a typical summer could triple, from about 35 heat-related deaths per summer to over 100 (although increased air conditioning use may not have been fully accounted for). Winter-related deaths are expected to change very little. The elderly, particularly those living alone, are at greatest risk.

Climate change could increase concentrations of ground-level ozone. Currently, ground-level ozone concentrations exceed national ozone health standards in some areas across the state. The Houston-Galveston area is classified as a "severe" nonattainment area, and the El Paso area is classified as in "serious" non-attainment. Ground-level ozone has been shown to aggravate respiratory illnesses such as asthma, reduce existing lung function, and induce respiratory inflammation. In addition, ambient ozone reduces crop yields and impairs ecosystem health. Air pollution also is made worse by increases in natural hydrocarbon emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

Warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Recently reported cases of malaria and dengue fever in Texas demonstrate the continued risk of these diseases. If conditions become warmer and wetter, mosquito populations could increase, thereby increasing the risk of transmission.

In addition, warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. These blooms damage habitat and shellfish nurseries and can be toxic to humans. About two-thirds of the Texas coastline was closed to shellfish harvesting in 1996 because of contamination by an unusually large bloom of marine algae, or "red tide." Consumption of contaminated shellfish can cause neurotoxic shellfish poisoning. Warming in the Caribbean may have contributed to this problem; future warming combined with local pollution most likely would continue to damage fish and shellfish and thus affect human health.

Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads,

causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

The Texas coastline is over 1,400 miles long. The coastline is composed of wind tidal flats, sandy marshes, salt marshes, and beaches. The Laguna Madre has over 350 square miles of wind tidal flats that provide nesting areas or rookeries for sea birds. The sandy marsh shoreline provides critical habitat for shorebirds, wading birds, endangered brown pelicans, and other birds. About 75% of the ducks and geese found in the United States move through the Texas coastal wetlands. The salt marshes provide a home for oysters and clams, and serve as nursery grounds for young shrimp, crab, and fish. These marshes protect the shorelines from erosion and also act as a purification system by filtering out many pollutants added to the waters by human activities.

At Galveston, sea level already is rising by 25 inches per century, and it is likely to rise another 38 inches by 2100. Brown shrimp catch in the U.S. Gulf Coast could fall 25% with only a 10-inch rise in sea level. Possible responses to sea level rise include building walls to hold back the sea, allowing the sea to advance and adapting to it, and raising the land. Each of these responses will be costly, either in out-of-pocket costs or in lost land and structures. For example, the cumulative cost of sand replenishment to protect the coast of Texas from a 20-inch sea level rise by 2100 is estimated at \$4.2-\$12.8 billion.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. If streamflow and lake levels drop, groundwater also could be reduced. In addition, more intense precipitation could increase flooding.

Several major river basins lie in part, or entirely, within Texas. Most of the state is drained by several south-flowing rivers, including the Neches, Trinity, Brazos, Colorado, San Antonio, and Nueces. Western Texas drains into the Rio Grande or its major tributary, the Pecos River. Unless increased temperatures are coupled with a strong increase in rainfall, water could become more scarce. A warmer and drier climate would lead to greater evaporation, as much as a 35% decrease in streamflow, and less water for recharging groundwater aquifers. Increased rainfall could mitigate these effects, but also could contribute to localized flooding. Additionally, climate change could give rise to more frequent and intense rainfall, resulting in flash flooding.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate

variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other sectors.

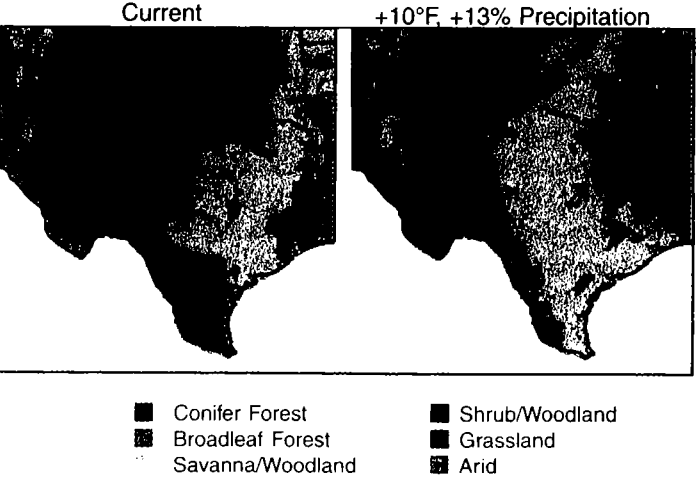
Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

In Texas, agriculture is a \$12.6 billion annual industry, two-thirds of which comes from livestock, especially cattle. About 25% of the crop acreage is irrigated. The major crops in the state are cotton, wheat, and sorghum. Climate change could reduce cotton and sorghum yields by 2-15% and wheat yields by 43-68%, leading to changes in acres farmed and production. For example, cotton yields could fall while production rises because of an increase in cotton acres farmed. Irrigated acreage could decline slightly because of decreased water availability.

Forests

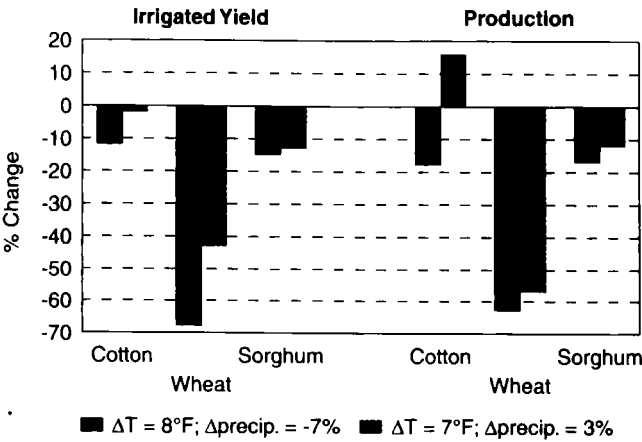
Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic range, and health and productivity. If conditions also become drier, the current range of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to warmer conditions, such as southern pines, would spread. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

Changes In Forest Cover



Source: VEMAP Participants (1995); Neilson (1995)

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

With changes in climate, the extent and density of forested areas in east Texas could change little or decline by 50-70%. Hotter, drier weather could increase wildfires and the susceptibility of pine forests to pine bark beetles and other pests, which would reduce forests and expand grasslands and arid shrublands. With increased rainfall, however, these effects could be less severe. In some areas, the types of trees dominating Texas forests would change; for example, longleaf and slash pine densities could increase in the deciduous forests of east Texas.

Ecosystems

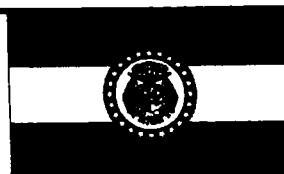
The vast area within Texas includes a great diversity of ecosystems, from forests to grasslands to semiarid shrublands to extensive coastal and inland wetlands. In Texas, climate change could weaken and stress trees, making them more susceptible to pine bark beetle outbreaks. Semi-arid grasslands and shrublands are very sensitive to changes in rainfall season and in the amount of rainfall, and could be affected adversely by warmer, drier conditions.

The Balcones Canyonlands National Wildlife Refuge in central Texas provides nesting grounds for the golden-cheeked warbler and the black-capped vireo, two endangered songbirds. Warmer and drier conditions could reduce critical habitat in the refuge and further stress sensitive plant and animal populations. The coastal wetlands, which support important fisheries and provide vital wildlife habitat, are also vulnerable to climate change. For example, Brazoria National Wildlife Refuge, a 43,388 acre coastal estuarine and coastal prairie habitat on the Gulf Coast, provides winter habitat for 30,000-40,000 ducks and 40,000 snow geese. The refuge also contains about 4,000 acres of native coastal bluestem prairie. Changes in rainfall and runoff from upland regions could adversely affect sensitive coastal systems, and sea level rise would accelerate loss of wetlands and estuaries, eliminating breeding and foraging habitat for commercial, game and threatened and endangered species.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.



 \$202.6 million will be saved by Missouri companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



MISSOURI

More ENERGY STAR Facts

- Missouri is home to 81 companies and public entities participating in ENERGY STAR partnerships.
- Over 151 million square feet of Missouri building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 290 times the size of the TWA Dome.
- 3 ENERGY STAR-Labeled Product manufacturers are located in Missouri.
- Investments already made through the ENERGY STAR program in Missouri will prevent over 5.2 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 708,000 acres of trees — an area 2,400 times the size of the University of Missouri-Columbia.
- Nitrogen oxide (NO_x) emissions will be reduced by 24.5 million pounds and sulfur dioxide (SO₂) by nearly 48 million pounds due to existing ENERGY STAR investments in Missouri.

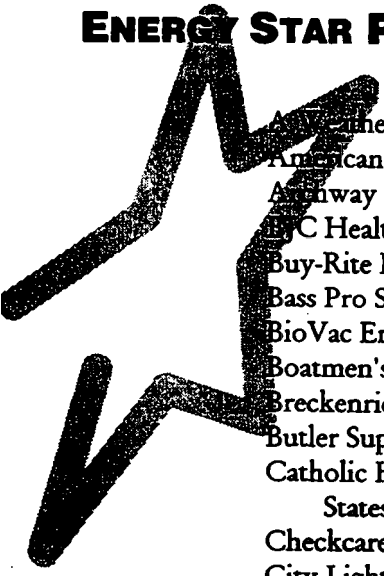
Highlights

- University of Missouri-Columbia received the ENERGY STAR Buildings Partner of the Year Award in 1997 and the Green Lights University Partner of the Year in 1995.

Market Potential

- Missouri has 1.6 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$467 million would be saved annually
 - The following emissions would be prevented each year:
 - 11.2 billion pounds of CO₂
 - 63.3 million pounds of NO_x
 - 124.6 million pounds of SO₂

ENERGY STAR Participants in Missouri



Americanization Co/Awxco
American Public Works Association
Arrowway Lighting Supply Inc.
B+C Health System
Buy-Rite IGA
Bass Pro Shops
BioVac Environmental Services
Boatmen's National Bank of Saint Louis
Breckenridge School District R1
Butler Supply, Inc.
Catholic Health Association of the United States
Checkcare Systems
City Lighting Products Company
City Utilities of Springfield
Clayton School District
Claywest House, Inc.
Colliers Turley Martin, Kansas City
Dow Screw Products, Inc.
Dazor Manufacturing Corporation
Deramus Education Pavilion
Economy IGA Foodliner
The Empire District Electric Company
Fayette Environmental Services
Gehm Environmental
Graybar Electric Company
HE Williams, Inc.
Herr Kater
Hallmark Cards Incorporated
Health Midwest
Heartland Commercial Coatings
Hydrodelta Corporation, Missouri
Independence School District
International Lighting Manufacturing Company
Kansas City Power & Light
City of Kansas City, Missouri
Kiel Center
Kingston Environmental Services
Liberty Hospital
The Loop Subway
Metropolitan Energy Center
Metropolitan Manufacturing Association
Mid-America Energy and Resource Partners
Missouri Energy Resources Project
Missouri Valley Electrical Company
The State of Missouri
Moberly's Finest

Monsanto Company
Nordyne, St. Louis MO
The Original Cast Lighting
Ozark Solar
Preferred Energy Services, Inc.
Queen's IGA
Ralston Purina Checkerboard Square
Headquarters
Raphael Hotel
Roziers Mercantile Company Incorporated
St. Louis Children's Hospital
Saint Louis Public Schools Board of Education
City of St. Louis, Missouri
Savings Technology
Semcor
Starbeam Supply Company
Subway #11927 St Charles
Subway #4840
Technical Services Laboratories
US Department of Energy
Missouri Army National Guard
Union Electric Company
United Electric Supply
United Energy of Missouri, Inc.
University of Missouri at Columbia
Venture Stores Inc.
Villa Lighting Supply, Inc.
Viron Energy Services
Warrensburg Chamber of Commerce
Washington University
Webster University
Western Extralite Company of Kansas City
Western Extralite Company of St. Louis
Westminster College
White Rodgers, Saint Louis
Wiegmann and Associates

Examples of Missouri Partners Saving Money and Helping the Environment

Independence School District

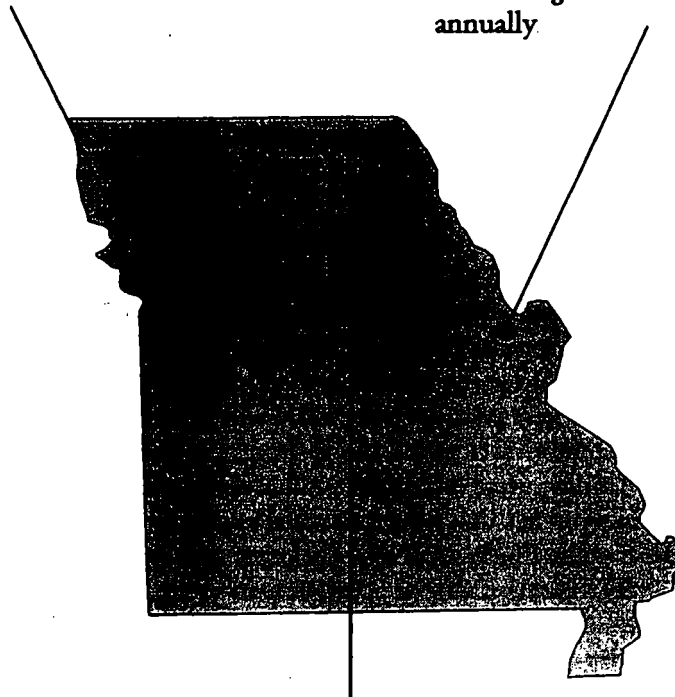
- Saving \$170,000 in annual energy costs
- Upgraded lighting for 1 million sq. ft.
- Reducing energy use by 1.7 million kWh annually
- Preventing 2.4 million pounds of CO₂ annually

Venture Stores Inc., O'Fallon

"After our upgrades, we are more competitive and can be one step ahead."

— Debbie Rachelis, Energy Manager

- Saving \$2 million in annual energy costs
- Replaced lighting for 12.5 million sq. ft.
- Reducing energy use by 25 million kWh annually
- Preventing 36 million pounds of CO₂ annually



University of Missouri-Columbia

"Students and staff benefit with more money for the University, and the community benefits with a better environment."

— Phil Shocklee, Assistant Director, Campus Facilities

- Saving \$515,000 in annual energy costs
- Upgraded lighting and HVAC for 3 million sq. ft.
- Reducing energy use by 7.5 million kWh annually
- Preventing 11.9 million pounds of CO₂ annually
- Incorporated energy efficiency issues into class

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services, and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Missouri

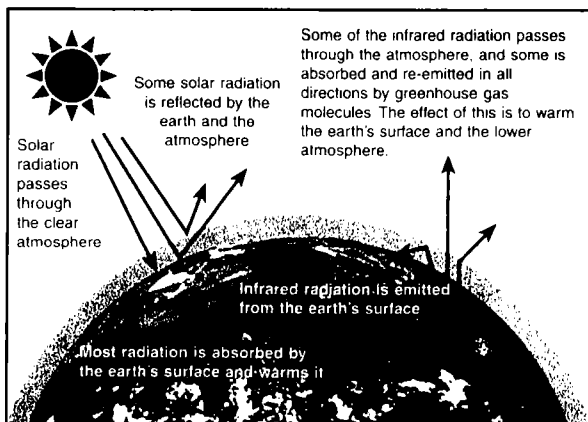
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

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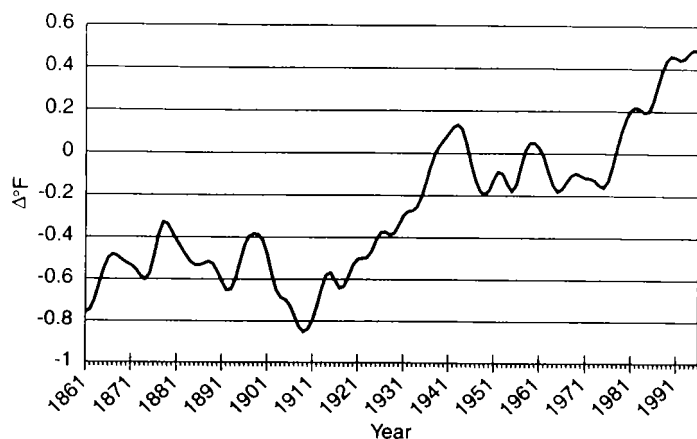
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Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

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General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

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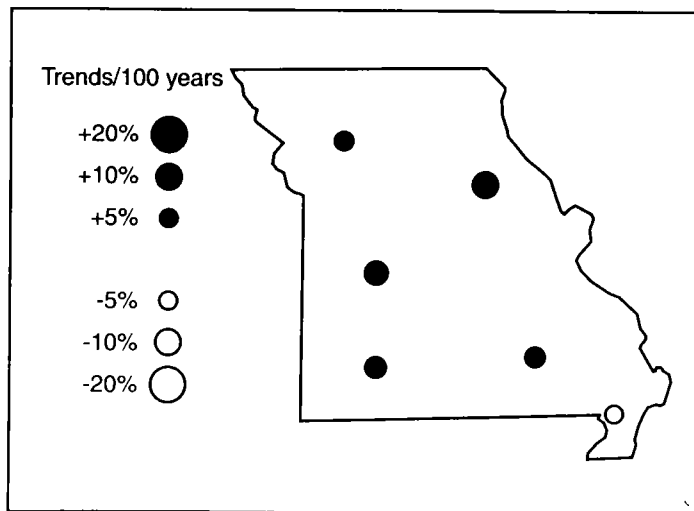
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Local Climate Changes

Over the last century, the average temperature in Jefferson City, Missouri, has decreased 0.5°F, and precipitation has increased by up to 10% in many parts of the state.

Over the next century, climate in Missouri could experience additional changes. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Missouri could increase by about 2°F in summer (with a range of 1-4°F) and about 3°F in the other seasons (with a range of 1-7°F). Little change is estimated for winter precipitation. Increases of about 15% are estimated for spring and fall, and the summer increase is estimated to range between 20 and 60%. Other climate models may show different results, with winter precipitation increasing more than summer precipitation. The amount of precipitation on extreme wet days in summer is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. Although it is not clear how severe storms would change, an increase in the frequency and intensity of summer thunderstorms is possible.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Missouri, with its irregular, intense heat waves, could be especially susceptible.

In St. Louis, one study projects that by 2050 heat-related deaths during a typical summer could increase 170%, from about 80 heat-related deaths per summer to over 200 (although increased air conditioning use may not have been fully accounted for). Winter-related deaths are expected to change very little. The elderly, particularly those living alone, are at greatest risk.

Climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbon emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

A 4°F warming in the Midwest, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by as much as 8%. Currently, the St. Louis area is classified as a “moderate” nonattainment area for ozone. Ground-level ozone has been shown to aggravate respiratory illnesses such as asthma, reduce existing lung function, and induce respiratory inflammation. In addition, ambient ozone reduces crop yields and impairs ecosystem health.

Warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue (“break bone”) fever. Mosquitos flourish in Missouri, and some carry St. Louis encephalitis. Also, the mosquitoes that carry dengue fever, Eastern equine encephalitis, and LaCrosse encephalitis recently have spread as far north as Chicago. Global warming could shift farther north the region where these mosquitoes breed and overwinter. If conditions become warmer and wetter, mosquito populations could increase, thereby increasing the risk of transmission of these diseases.

Water Resources

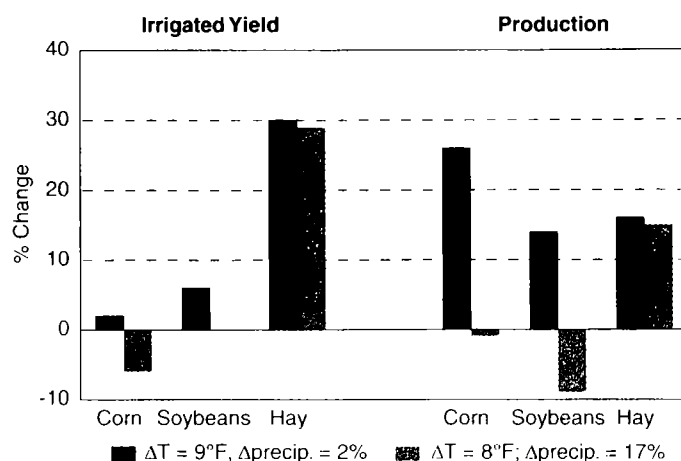
Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. If streamflow and lake levels drop, groundwater also could be reduced. In addition, more intense precipitation could increase flooding.

The Missouri River drains about two-thirds of the state. The remainder of the rivers in the state drain directly to the Mississippi River, except a few in the southern portion of the state that drain into the Arkansas River. The Missouri, Mississippi, and Arkansas are all large rivers, whose flows are mostly generated outside and well upstream of the state (for example, in Montana and Wyoming). Increased rainfall could lead to localized flooding. However, summer flows could be reduced considerably if summer rainfall decreases. These conditions could present a range of problems for municipal and industrial water supply, as well as for instream water uses such as navigation and recreation.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other sectors.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

In Missouri, agriculture is a \$4 billion annual industry, one-half of which comes from livestock, especially cattle. Less than 10% of the crop acreage is irrigated. The major crops in the state are corn, soybeans, and hay. Corn and soybean yields could fall by as much as 22% or rise by as much as 6%, depending on whether irrigation is used. Hay yields could increase by about 30%. These yield changes could lead to changes in acres farmed and production. For example, corn yields could increase only slightly while production rises substantially because of an increase in corn acres farmed.

Forests

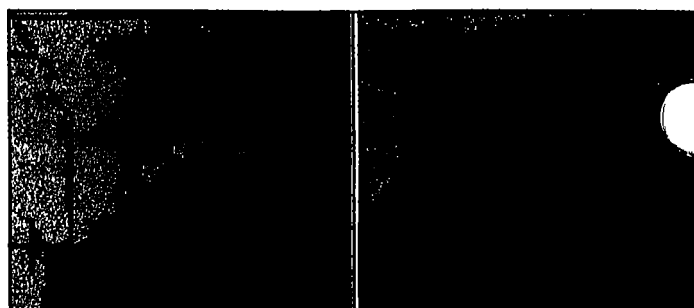
Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic range, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to warmer conditions, such as oaks and southern pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Missouri could change little or decline by as much as 10-20%. The uncertainties depend on many factors, including whether soils become drier and, if so, how much drier. Hotter, drier weather could increase the frequency and intensity of wildfires, whereas increased rainfall could reduce their severity. In areas with richer soils, the range and density of southern pines could increase and become more dominant within the oak and hickory forests that predominate in southern Missouri and in the Ozarks. In areas with poorer soils, which are more common in Missouri's forestlands, scrub oaks of little commercial value (e.g., post oak and blackjack oak) could increase. Grasslands and savanna eventually

Changes In Forest Cover

Current

+10°F, +13% Precipitation



- Broadleaf Forest
- Savanna/Woodland
- Grassland

Source: VEMAP Participants (1995); Neilson (1995)

could replace forests and woodlands in northern Missouri. These changes would significantly affect the character of Missouri forests and the activities that depend on them.

Ecosystems

Ecosystems in Missouri include extensive forests, rivers, streams, and prairies. The Ozark Mountains contain several rivers designated as "Wild and Scenic" by Congress; these rivers also provide winter habitat for many bald eagles. Riparian and stream ecosystems are especially sensitive to changes in rainfall. Water temperature changes caused by climate change could reduce habitat for smallmouth bass, northern pike, and other species such as walleye and yellow perch.

Changes in temperature and rainfall could shift the types and locations of habitats and ecosystems, in particular, the tallgrass prairies. Climate change could increase pressure on Missouri prairie lands from non-native plants. Prairie State Park, which is Missouri's largest remaining tallgrass prairie, provides habitat for approximately 150 bird species and 25 rare or endangered species. The park also contains Missouri's most pristine prairie headwater stream, East Drywood Creek, and wildlife such as the American bison, elk, greater prairie chicken, northern harrier, upland sandpiper, scissor-tailed flycatcher, and coyote. The fragmented prairie could impede migration of some plants and animals vulnerable to climate change.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.



 \$1.4 billion will be saved by California companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



CALIFORNIA

More ENERGY STAR Facts

- California is home to 444 companies and public entities participating in ENERGY STAR partnerships.
- Over 905 million square feet of California building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 5700 times the size of the Great Western Forum.
- 64 ENERGY STAR-Labeled Products manufacturers are located in California.
- Investments already made through the ENERGY STAR program in California will prevent over 28 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 4 million acres of trees — an area 22 million times the size of the University of California-Berkeley.
- Nitrogen oxide (NO_x) emissions will be reduced by over 41 million pounds and sulfur dioxide (SO₂) by over 27 million pounds due to existing ENERGY STAR investments in California.

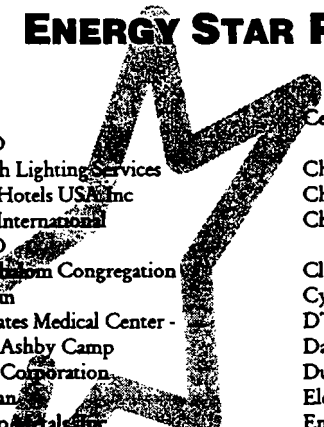
Highlights

- Mervyn's received the ENERGY STAR Buildings Retail Award and Amtech received the Green Lights Ally of the Year Award in 1999.
- Walt Disney World Company received the ENERGY STAR Buildings Hospitality Partner of the Year Award in 1998.
- Hewlett-Packard received the ENERGY STAR Office Equipment Best Technical Innovation Award in 1997 and Printers Partner of the Year in 1996.
- The following California companies received ENERGY STAR awards in 1997:
 - Bank of America (San Francisco), Green Lights Large Corporate Partner of the Year
 - Samsung Electronics, ENERGY STAR Office Equipment Monitor Partner of the Year
- The State of California and the County of San Diego received the Green Lights Government Partner of the Year Award in 1996.

Market Potential

- California has over 9 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$4 billion would be saved annually
 - The following emissions would be prevented each year:
 - 68 billion pounds of CO₂
 - 164 million pounds of NO_x
 - 121 million pounds of SO₂

ENERGY STAR Participants in California



OM	Centinela Hospital Medical Center	National Semiconductor Corporation	Tisch Avnett
ACCO	Chevron	Nestle USA	Tooley & Company
Amtech Lighting Services	ChildHelp USA	Novitas, Inc.	Torrance Memorial Hospital
ANA Hotels USA, Inc.	Christ The Lord Episcopal Church	PARAS, LLC	Toshiba America Information Systems
AOC International	Clovis School District	PG&E Energy Services	Totoku Electric Co., Ltd.
ARGO	CyberVision	Pacific Bell	Toyota Motor Sales USA Inc
Adar Shalom Congregation	DTK Computer, Inc.	Pacific Gas & Electric	Transamerica Corporation
Allegan	Daylite Company	Packard Bell	Transmonde Technologies, Inc.
Alta Bates Medical Center - Ashby Camp	Dura Pharmaceuticals	Pajaro Valley Unified School District	Troy Lighting, Inc.
Altera Corporation	Electric Power Research Institute	Parke Industries, Inc	Twinhead Corporation
AmTrans	Energy Data Company, Inc.	Patagonia	U.S. Energy Technologies Inc.
Amalco Metal, Inc.	Energy Matrix	PowerLux Corporation	UMAX Computer Corporation
Amdahl Corporation	Energy Saving Products, Inc	Ralph's Grocery Company	California Army National Guard
American Steel Corp	Enerttron Technologies, Inc.	Raychem Corporation	US Green Building Council
Apple Computer, Inc.	Esprit	Raytheon Systems Company, Sensors & Electronic Systems	Energy Management Engineering, Inc, EME
Apple Materials, Inc.	Garden Fresh Restaurant Corporation	Ricoh Electronics	Stanford Linear Accelerator Center (USDOE)
Arch Electric Company	General Motors Hughes Electronics - Corp. Hdqrs	Robert F. Kennedy Medical Center	Veterans Affairs Medical Center, Palo Alto
Associated Students of UC Berkeley	Hewlett-Packard Company	Rockwell International Corporation	USA Energy Corporation
Association of Professional Energy Managers	Hilton Hotels Corporation	SAIC	USIE of America Incorporated
BP Solar, Inc.	Hitachi PC Corporation	SMUD (Sacramento Municipal Util Dist)	USPAR Ent. Inc.
Bank of America	Hughes Space and Communications Company	Safeway Inc.	Unihealth America (PHR)
Bechtel Group, Inc.	Huntington Memorial Hospital/CA	Samsung Electronics	University of California at Berkeley
The City of Berkeley, California	Hyundai Electronics America	The City of San Diego, California	University of San Diego
Biola University	In-n-Out Burger, A California Corporation	San Diego County, California	University of Southern California
Bordeaux Drive Limited Partnership	Intel Corporation	Sanyo Information Business	V. Felton Liquors
Brayer Lighting, Inc.	Kaiser Foundation Healthcare Incorporated	Siemens Information & Communications	Ventura County, California
Buckles-Smith Electric Co.	Kenwood U.S.A. Corporation	Network Inc.	Verle A. Williams & Associates, Inc.
Business for Social Responsibility	Kinko's Service Corporation	Sign-Wize	Videssence, Inc.
Butte College at Oroville	Local Government Commission	Southern California Edison Company	ViewSonic Corporation
C. W. Cole & Co., Inc.	Los Angeles Area Chamber of Commerce	Southern California Gas Company	Viking Freight System, Inc.
Calcert Company	Los Angeles Department Of Water & Power	Southwestern College	Villa View Community Hospital
CLI Fixtures, Inc.	Los Angeles Jewish Homes for the Aging	Spectrolab Incorporated	Vista Universal, Inc.
Clicktours	Los Angeles Unified School District	St Mar Enterprises Inc.	Volt Viewtech Inc.
Concept Fusion	Los Angeles Valley College	St. John's Episcopal	W & W Rice Company
Coptech West	The City of Los Angeles, California	St. Elizabeth's Day Home	Western Pete
CRI Lighting	County of Los Angeles, California	Stanford Health Services	Walnut Valley Unified School District
CSL Lighting Manufacturing, Inc.	Louisiana-Pacific Corporation Western Division	Stanford University Academic Facilities	Walt Disney Studios
CSS Laboratories, Inc.	Division	State Compensation Insurance Fund	Warner Technologies
CTSI Corporation	Lucky Stores Incorporated Southern Division	Stingray Lighting, Inc.	The Watt Stopper Inc.
CTX International, Inc.	Lumatech Corporation	Subway #16469 Pomon, CA	Wellmade Metal Products Co
CalComp Inc.	MGM Lighting, Inc.	Sumitomo Bank of California	Westerfield Co.
California Chamber of Commerce	Mattel Inc.	Summit Medical Center	Western Digital Corporation
California Commercial Lighting	Media On	Sun Microsystems Computer Corp.	Western Financial Savings Bank
California Department of Education	Mendocino Brewing Company	Sun Microsystems, Incorporated	Western Lighting Company
California Municipal Utilities Association	Mervyn's	Sunshine Makers Inc/ Simple Green	Western Partnership for Environmental Technology Education
California Society of Hospital Engineering, Inc.	Mitsubishi Heavy Industries, Climate Control, Inc.	Syska & Hennessy / CEM	Wild Brain
California State Association of Counties	Nalmco	Technology Advantage	Yamaha Corporation of America
California State Automobile Association		TMP, Inc.	Yosemite Community College District
California State University System		Team Terno Enterprises, DBA The Hanford House	
California Steel Industries, Inc.		Techmedia Computer Systems Corporation	
California Trade & Commerce		Tenet Healthcare Corporation	
The State of California			
Carl's Jr. Restaurants			

Examples of California Partners Saving Money and Helping the Environment

Bank of America, San Francisco

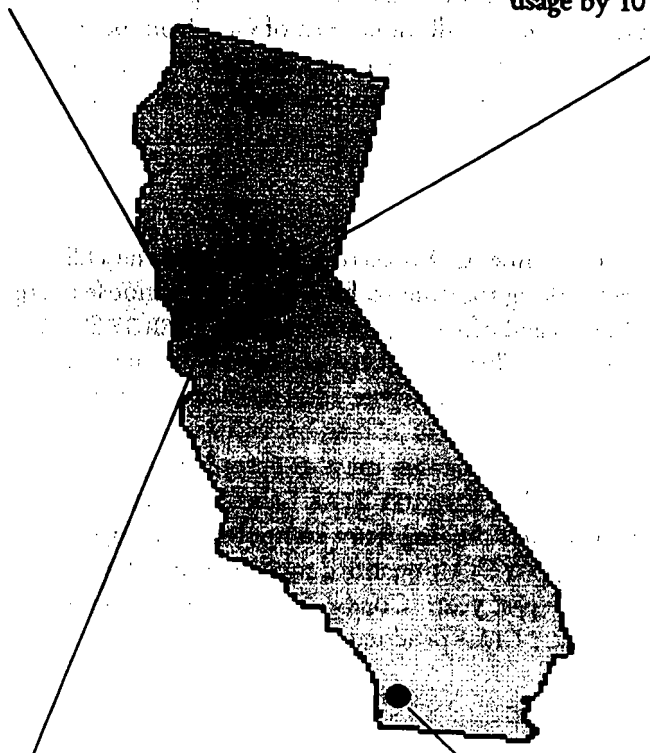
"The corporation's environmental program is dedicated to demonstrating the fundamental link between a strong economy and a healthy environment."

- Marty Stein, Vice Chairman
- Saving \$4 million in annual energy costs
- Upgraded lighting in 17 million sq. ft.
- Reducing energy use by 44 million kWh annually
- Preventing 50 million pounds of CO₂ annually

Kaiser Foundation Healthcare Inc., Oakland

"[Energy efficiency] enables us to cut energy costs without compromising patient care."

- Kip Edwards, Vice President of Facilities
- Saving \$1 million in annual energy costs
- Reducing energy use by 12.6 million kWh annually
- Preventing 15.2 million pounds of CO₂ annually
- Established a national energy management group tasked with reducing overall energy usage by 10 to 15 percent



Power Integrations, Sunnyvale

- Developing a switch that will significantly reduce energy consumption in the standby state for devices with remote controls, timers, sensors, and charging requirements
- Could reduce by 70 percent the domestic energy currently lost to "leaking electricity" in these devices

San Diego County

"We have come out of this process not only with great savings, but with a modern inventory of mechanical equipment and a better building environment."

- Tom DuMont, Deputy Director / Facilities Service Department
- Saving \$1 million in annual utility costs
- Reducing energy use by 10 million kWh annually
- Preventing 10 million pounds of CO₂ annually
- Completed further upgrades to the heating, air-conditioning, and ventilation systems in one complex of nine buildings

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$3.5 billion and prevent 78 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3000 participants, representing close to one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs upfront, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. Consumers are now saving over \$1 billion a year by bringing ENERGY STAR products into their homes.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And California

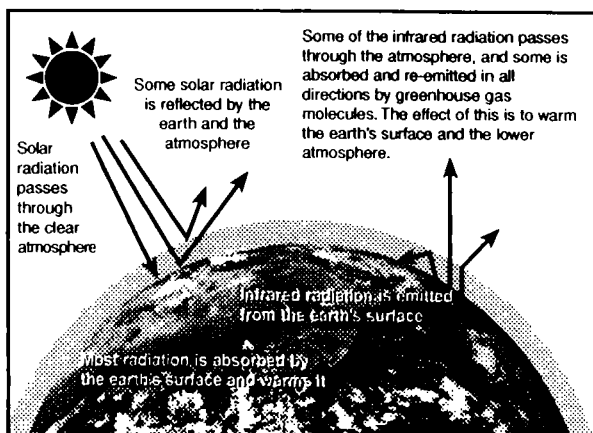
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

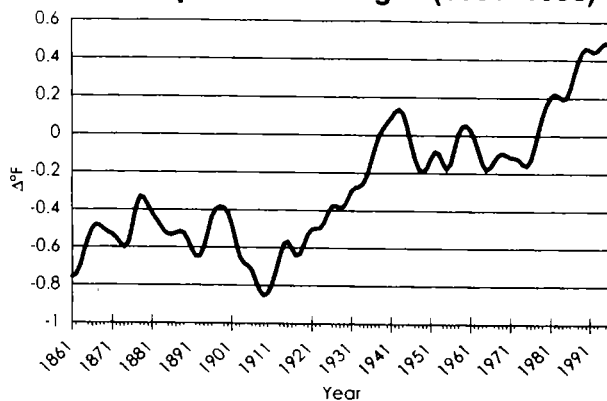
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F since the late 19th century. The 9 warmest years in this century all have occurred in the last 14 years.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen 4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. Scientists are reasonably confident about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, and associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in Fresno, California, has increased from 61.9°F (1899-1928 average) to 63.3°F (1966-1995 average), and precipitation has decreased by up to 20% in many parts of the state.

Over the next century, California’s climate may change even more. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in California could increase by about 5°F (with a range of 2-9°F) in the winter and summer and slightly less in the spring and fall. Appreciable increases in precipitation are projected: 20-30% (with a range of 10-50%) in spring and fall, with somewhat larger increases in winter. Little change is projected for summer.

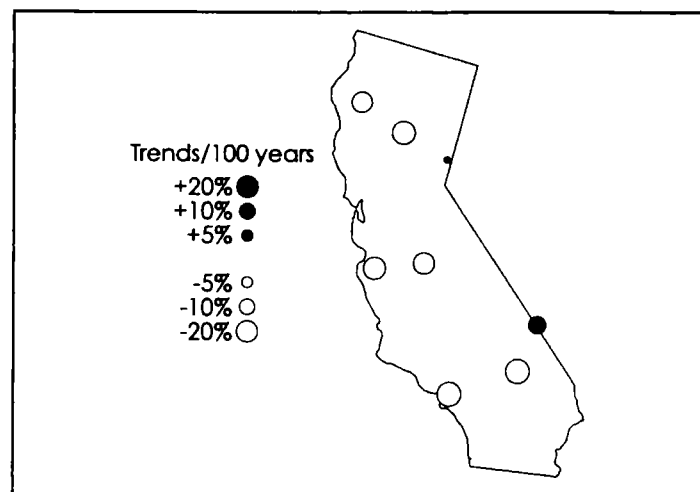
The amount of precipitation on extreme wet days most likely would increase, especially in the winter and fall, and there could be a decrease in the number of long dry spells and an increase in the number of long wet spells.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Cities such as Los Angeles that experience occasional very hot, dry weather may be especially susceptible. The study estimates that a 3°F warming could almost double heat-related deaths in Los Angeles, from about 70 today to 125 (although increased air conditioning use may not have been fully accounted for). Little change in winter mortality is expected in Los Angeles. The elderly, particularly those living alone, are at greatest risk.

There is concern that climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbons emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

In the Bay Area and the Central Valley, with no other changes in weather or emissions, a 7.2°F warming would increase ozone concentrations by 20% and almost double the size of the area not meeting national health standards for air quality. Currently, the national standards for ozone are not attained throughout much of the state. Ground-level ozone has been shown to aggravate existing respiratory illnesses such as asthma, reduce lung function, and induce respiratory inflammation. In addition, ambient ozone reduces agricultural crop yields and impairs ecosystem health.

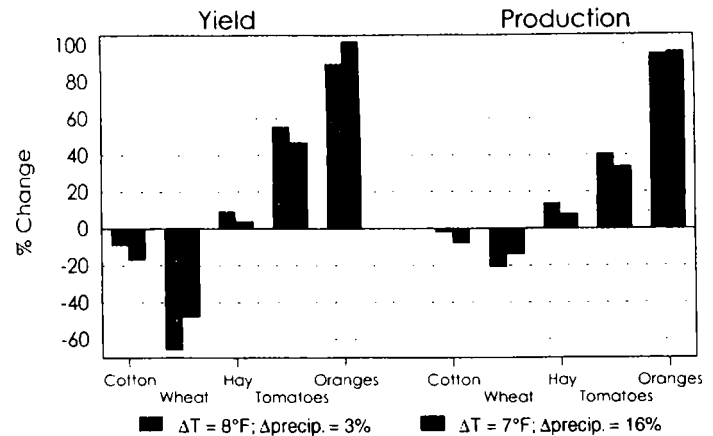
Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

In California, agriculture is about a \$19 billion annual industry, one-third of which comes from livestock. About 3% of total U.S. farm acres is in California. The principal crops are cotton, wheat, hay, tomatoes, and oranges, as well as many other vegetables and fruits. About 87% of the acres farmed is irrigated. While climate change could decrease cotton yields by 9-17% and wheat yields by 48-66%, hay, orange, and tomato yields could increase. Total

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

acres farmed and irrigated acres could fall slightly, and farm income could remain unchanged or increase by up to 40% because of possible price increases.

Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

Along much of California's coast, sea level already is rising by 3-8 inches per century (3 inches at Los Angeles, 5 inches at San Francisco, and 8 inches at San Diego), and it is likely to rise by another 13-19 inches by 2100. The beaches stretching from Santa Barbara to San Diego have been replenished with sand, and undoubtedly will be replenished further or protected with structures if threatened by sea level rise. Cumulative costs for sand replenishment to protect California's coastline from a 20-inch sea level rise through 2100 could be \$174 million to \$3.5 billion.

San Francisco Bay contains the most extensive salt marshes on the West Coast, most of which have been modified dramatically by dredging and filling activities. A 1-3 foot increase in sea level may move the existing salt marshes in the bay to nearby lowlands and freshwater marshes, but development probably will limit the extent to which these marshes can "migrate" to new areas.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer

climate, it could result in lower river flow and lower lake levels, particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

The seasonal pattern of runoff into California's reservoirs could be susceptible to climatic warming. Winter runoff most likely would increase, while spring and summer runoff would decrease. This shift could be problematic, because the existing reservoirs are not large enough to store the increased winter flows for release in the summer. Increased winter flows to San Francisco Bay could increase the risk of flooding. The fragile environment of the bay's delta islands could be at risk from increased flooding and the upstream movement of saltwater from the bay.

Because the Colorado River, the major water source for southern California, has extensive storage capacity, the reliability of this water supply to California is not vulnerable to seasonal changes. However, it is not known if flow in the Colorado River will increase or decrease under climate change.

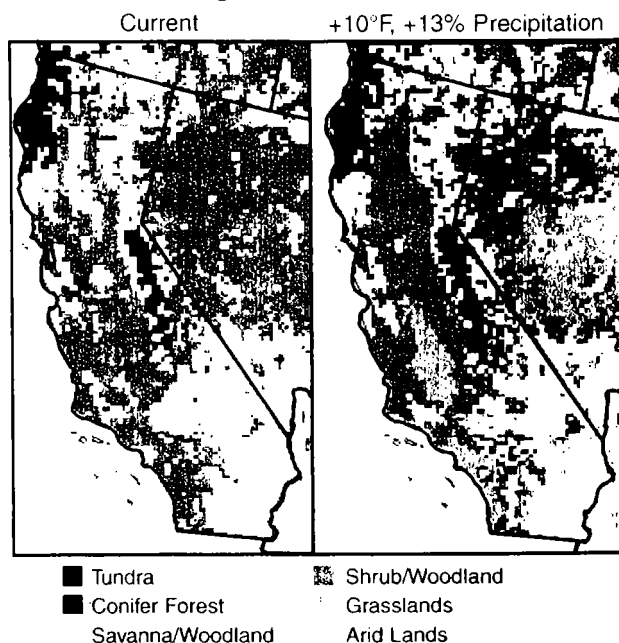
California's groundwater supplies are likely to be affected by climate change as well. Unless precipitation increases, the increased evaporation that would accompany warmer temperatures probably would reduce groundwater supplies.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to these conditions, such as oaks and redwoods, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in California could change little or decline by as much as 25-50%. The uncertainties depend on many factors, including whether soils become drier and, if so, by how much drier. Hotter, drier weather could increase the frequency and intensity of wildfires, threatening both property and forests. Along the Sierras, drier conditions could reduce the range and productivity of conifer and oak forests. Farther north and along the northern coast, drier conditions could reduce growth of the Douglas fir and redwood forests. A significant increase in the extent of grasslands and chaparral throughout the state could result. These changes would affect the character of California forests and the activities that depend on them.

Changes In Forest Cover



Source: VEMAP Participants (1995); Neilson (1995)

Ecosystems

California is an ecologically diverse state, with 134 endangered and threatened species, including the sea otter, the California condor, and the American bald eagle. California's unique ecosystems include 25,000 square miles of desert (such as the Mojave desert and the Colorado desert). California's mountain ecosystems in the Sierra Nevada, including Yosemite National Park's 1,200 square miles, contain alpine wilderness areas with large numbers of sequoia trees. The ranges of many species of plants and animals are restricted and fragmented because of both natural and human causes. Many invading species have colonized large areas and displaced native species in the wake of environmental changes in recent centuries.

Climate change could have an impact on many of California's species and ecosystems. For example, between 1992 and 1996 the range of the bay checkerspot butterfly shifted 130 miles to the north and to higher altitudes as a result of climate change. Without natural corridors to allow migration, isolated species could be limited in their ability to adapt to climate change. Plant and animal species near the borders of their ranges are likely to be most affected. Climate change could create more opportunity for the establishment and spread of weeds and pests. Increased fire from climate change could further threaten species in California.

Cold water species such as mountain whitefish and brook trout could lose all of their habitat because of climate change. Other cold water species such as cold water guild, chinook salmon, and kokanee salmon could lose most of their habitat.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.



Climate Change Mitigation in California

California's Greenhouse Gas Emissions (1990)¹

- Total greenhouse gas emissions in the baseline year, 1990, were about 113 million metric tons of carbon-equivalent, about 8.5% of the U.S. total.
- Per capita emissions in 1990 were about 4 tons per person, lower than the 1990 national average of about 5.
- The major source of energy-related greenhouse gas emissions in California was transportation, which accounted for 57% of fossil fuel emissions.
- The second highest source of greenhouse gas emissions in California was industry, which accounted for at least 16% of emissions, followed by electricity.

Mitigation Policy Planning:

- In January 1998, the California Energy Commission published the *1997 Global Climate Change Report: Greenhouse Gas Emissions Reduction Strategies for California*. The box below lists the policies recommended in the report².

Policies Recommended by California:

Energy Efficiency: Residential, Commercial, and Industrial

- Fund energy efficiency programs
- Promote voluntary industrial sector energy efficiency/GHG emissions reductions programs
- Promote alternative California oil and natural gas production technologies

Electricity Generation: Utilities

- Account for environmental externalities in assessing costs of energy production, resource planning, and procurement
- Promote high-efficiency gas (HEG) generation technologies
- Promote integration of renewable generating technologies into electricity system
- Fund renewable resource development and commercialization during transition to a market-driven economy

Transportation:

- Continued development and promotion of clean, alternative fuel vehicles
- Continued alternative fuel vehicle infrastructure development
- Promote research and development on Biomass-based alcohol fuels
- Reduce vehicle miles traveled in personal vehicles via VMT fees/taxes, congestion fees, and other pricing measures
- Higher fuel economy standards
- Promote improved and expanded transportation alternatives with incentives (fuel subsidies and vehicle purchase incentives),
- Alternative Expand land use planning to incorporate long-term transportation needs and promote strategies for better management of transportation demand and air pollution.

Other:

- Improve forestry management for carbon sequestration
- Improve solid waste management for methane and CO₂ reductions (recycling)
- Improve livestock management for methane emissions reductions

Existing California Policies that reduce greenhouse gas emissions³:

Sample of Existing Policies or Programs:

Electricity Generation

- Net Metering (Law)
- Solar Energy Rebates
- Non-bypassable Distribution Charge
- Green Pricing programs (Greenergy, PV Pioneers)
- Retail electricity disclosure program and green labeling
- Solar contracting and licensing, equipment certification programs
- Solar access laws and the Solar Shade Control Act

Residential & Commercial: Energy efficiency

- Energy efficient mortgages
- Tree planting initiatives
- Geothermal Grant & Loan program
- Opportunity technology commercialization program
- Energy Technologies Advancement Program
- Small business energy loan program

Transportation

- Requirement of low- and zero-emission auto sales
- Trip reduction ordinances
- Alternative fuel vehicle rebate program
- Transportation Energy Technologies Advancement program

Benefits of Reduced Reliance on Fossil Fuels: Increased opportunities for California

Increases in renewable energy use and energy efficiency improvements would provide new economic opportunities for many industries. California already reaps some benefits from reduced reliance on fossil fuels. For example, 33% of all U.S. solar collector shipments, valued nationally at \$29.8 million in 1996 (EIA Renewable Energy Outlook 1997), originated in California. Similar industries in California could experience gains from a shift away from fossil fuels.⁴

Solar-related Products and Services:

- *Companies include:* Anada Power Technologies in Nevada City, The Art of Solar in Newport Beach ; Atlantis Energy in Grass Valley; FAFCO in Redwood City; Ferro Corporation in Santa Barbara, Heinz Solar in Desert Hot Springs, Heliodyne in Richmond; Kyocera America, Inc. in San Diego; Laing Thermotech in Chula Vista; Photovoltaics International, LLC in Santa Clara; Morley Manufacturing in Cedar Ridge; Pistachio Pump in Sanger; Radco Products in Santa Maria; Sealed Air Corporation in Hayward; Siemens Solar Industries in Camarillo; Solar Electric in San Diego; Solec International, Inc. in Hawthorne; Sun Utility Network in Los Angeles; United Solar Systems in San Diego; and BP Solar in Fairfield.

Wind-related Products and Services:

- *Companies include:* Green Power Partners, LTD in San Rafael, Flowind Corporation in Tehachapi, Zond Corporation in Tehachapi, Cannon Energy Corporation in Tehachapi

Insulation-related Products and Services:

- *Companies include:* BP Chemicals Hitco, Inc. in Gardena; Certain Teed Corporation in Chowchilla; Greenstone Industries, Inc. in Sacramento; The Celotex Corporation in Tracy; and Owens-Corning Fiberglass in Santa Clara.

Win-Win Climate Mitigation Projects in California⁵

The Cities of Berkeley, Chula Vista, Los Angeles, Oakland, San Francisco, San Diego, San Jose, Santa Monica, and West Hollywood, and the State and Local Climate Change Program

- As participants in the Cities for Climate Protection Campaign, these cities have each committed to conducting an emissions inventory, adopting an emissions reduction target, developing an action plan, and implementing strategies to achieve their target.

- The City of Berkeley's Municipal Energy Retrofit Program is saving \$90,000 and 500 tons CO₂ annually. The Berkeley Energy Office has also developed policies and assistance programs to facilitate commercial and low-income residential energy conservation.
- Through Transportation Partners, Chula Vista is promoting telecommuting via its Neighborhood Telecenters Program and distance learning classes. Combined, these programs enable the participants to reduce the number of vehicle trips taken by 7,820 and reduce the total vehicle miles traveled in Chula Vista by 5,400 each year.

Fetzer Vineyards and Climate Wise

- Partner Fetzer Vineyards has committed to a total energy use reduction of 50% by 2005. Initiatives include photovoltaic measures, alternative fuel vehicles and general process improvements.

Bank of America and Waste Wise

- Bank of America conserved 4,108,000 pounds of paper through office paper reduction efforts in 1996.

The Clorox Company and Waste Wise

- Through lightweighting and concentration of products, The Clorox Company conserved 6,800,000 pounds of corrugated paper for packaging in 1996. The company also implemented a test product giveaway program that eliminated 100,000 pounds of various product wastes while providing free cleaners to several non-profit agencies.

Hewlett-Packard Corporation and Waste Wise

- Hewlett-Packard Corporation shifted from paper/foam cups to reusable mugs at coffee stations, reducing paper and polystyrene waste by 210,000 pounds. Hewlett-Packard also redesigned the packaging for its ink-jet printer cartridges resulting in a reduction of 2.8 million pounds of various packaging materials.

The Walt Disney Company and Waste Wise

- The Walt Disney Company established a computerized tracking system to allow for the revamping and reuse of studio sets conserving 528,000 pounds of wood.

NOTE: This compilation is a work in progress. For comments, corrections, questions, or additions, please contact Denise Mulholland of the U.S. EPA State and Local Climate Change Program at 202-260-4005 or mulholland.denise@epa.gov.

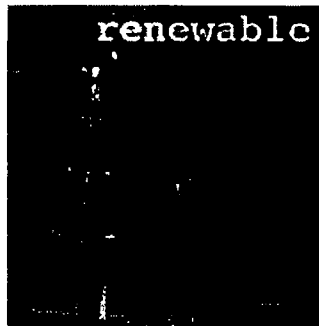
¹ Source: 1997 Global Climate Change: Greenhouse Gas Emissions Reduction Strategies for California, Volume 2, Appendix A, California Energy Commission, January 1998.

² Source: Ibid.

³ Sources: National Conference of State Legislatures Energy Newsletter, Vol.4, Number 3, Winter 1997; The Green Power Network, U.S. Department of Energy EREN, www.eren.doe.gov/greenpower, October 5, 1998; State Renewable Energy News, Volume 6, No.1, Winter 1997, NARUC Subcommittee on Renewable Energy; Green Power Newsletter, Number 6, March 1998, The Regulatory Assistance Project, www.rapmaine.org; Colorado Solar Energy Industries Association, www.coseia.org/rebate.html, August 1998; Renewable Energy Sourcebook: A Primer For Action, Public Citizen, www.citizen.org/CMEP/renewables, June 1998; Green Power Notes, Center for Energy Efficiency and Renewable Technologies (CEERT), Center for Resources Solutions (CRT), and Renewable Energy Marketing Board (REMB), www.cleanpower.org and www.green-e.org, June 1998; The States and Global Climate Change: Adopted and Proposed Initiatives, Submitted by The Center for Policy Alternatives, prepared by The Harrison Institute for Public Law, 1997; State and Local Legislative and/or Administrative Actions Having Direct or Incidental Effects on Greenhouse Gas Emissions, Center for Global Change, April 1992; Database of State Incentives for Renewable Energy, North Carolina Solar Center and Interstate Renewable Energy Council (IREC), www-solar.mck.ncsu.edu, May 1998; Government Actions on Climate Change in the Metropolitan NY/NJ/CT Region, Regional Plan Association, March 1998;

⁴ The Source for Renewable Energy, <http://www.sourceguides.com/energy/businesses>, October 1998.

⁵ U.S. Communities Acting to Protect the Climate: A Report on the Achievements of ICLEI's Cities for Climate Protection -U.S., International Council for Local Environmental Initiatives, November 1997; EPA Program managers as of November 1997. For further information, please see www.epa.gov/globalwarming.

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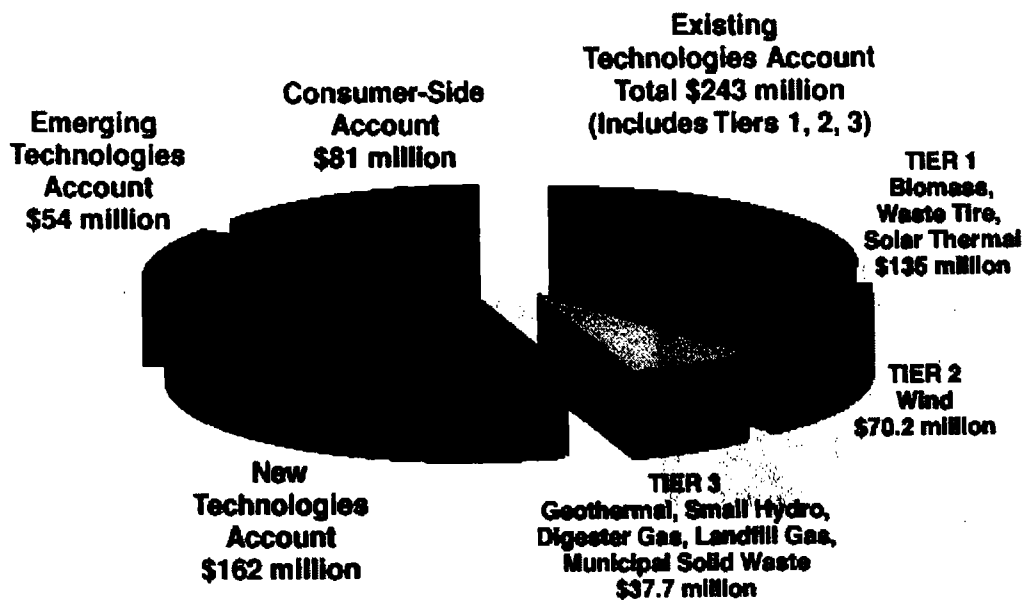
Renewable Energy Programs Overview

The California Energy Commission, with the passage of Senate Bill 90 (Senator Sher), has the authority to administer funds collected from the state's investor-owned utilities to support renewable energy technologies. Assembly Bill 1890 (AB 1890), which also deregulated the electricity industry, established a new statewide renewables policy by providing \$540 million collected from Southern California Edison, Pacific Gas and Electric Company, and San Diego Gas & Electric over four years beginning in 1998 to support existing, new and emerging renewable technologies from 1998 to 2001. Two potential additional sources of funds are voluntary contributions from customers and contributions from municipal utilities.

AB 1890 also required the Energy Commission to submit a report to the Legislature (*Policy Report on AB 1890 Renewables Funding*, publication number 500-97-002 -- [available for downloading](#)) outlining allocation and distribution recommendations for those renewables funds. This report, as adopted by the Legislature, became SB 90 - the administrative guidelines for the Renewables Program.

Senate Bill 90 implements the report's recommendations and creates a Renewable Resource Trust Fund containing four accounts: the Existing Renewable Resources Account, the New Renewable Resources Account, the Emerging Renewable Resources Account (Buy-Down Program), and the Customer-Side Renewable Resources Account.

Funds are divided among accounts and technologies as follows:



Renewables Program Funding

- Funds for existing technologies are distributed through a cents per kilowatt hour production incentive, with a cap of 1.5 cents per kilowatt-hour. Funds for existing technologies may decrease annually from January 1, 1998, to January 1, 2002, to increase the development of increasingly competitive technologies. Generators must apply and be approved for registration from the Energy Commission to be eligible to receive monthly payments for their renewable generation, with January 1998 as the first eligible generation period.

For information on payments made to date, please see the [Existing Renewable Resource Account](#) page.

- Funds for new technologies will be distributed through a production incentive based on a competitive solicitation process, with a cap of 1.5 cents per kilowatt-hour, and be paid over a five-year period after a project begins generating electricity. No single project can receive more than 25 percent of these funds. The amount of funds may increase annually from January 1, 1998, to January 1, 2002.

The competition auction was held in June 1998. For results, please see the [New Renewable Resource Account](#) page.

- Funds to emerging technologies will be provided through rebates, buy-downs or equivalent incentives to purchasers, lessees, lessors or sellers of eligible electricity generating systems. Eligible technologies are photovoltaic, solar thermal electric, fuel cell technologies that use renewable fuels, and wind turbines of 10 kilowatts or less.

For more information, please see the [Emerging Renewable Buy-Down Program](#) page.

- Funds to the customer-side account are divided into two subaccounts. The Customer Credit subaccount contains \$75.6 million that will be used for customer rebates for the purchase of renewable energy produced by certified energy providers, with a cap of 1.5 cents per kilowatt-hour and a limit of \$1,000 in rebates for industrial customer. These funds will increase annually from January 1, 1998, to January 1, 2002. The Consumer Education subaccount contains \$5.4 million that will be used to help develop a consumer market for renewable energy.

For more information about these accounts, please see the [Customer Credit](#) page and the [Consumer Education](#) page.

- Milestones for the renewables programs include:

Energy Commission adoption of implementation strategies	January 1998
Payments began for existing technologies account	March 1998
Notice of Auction released for new technologies account	March 1998
Buy-down reservation forms first accepted for emerging technologies account	March 1998
Bid deadline for new technologies account	June 5, 1998
Bid results for new technologies account released	July 3, 1998
Approval of Renewable Energy Consumer Education (RECE) Marketing Plan	February 17, 1999
Approval of a contract to administer a portion of the marketing plan focused on the "green" energy market	March 17, 1999

Documents and Forms to apply for these various accounts are available on the [documents page](#).

For specific areas of the Renewables Program contact the following:

Area	Contact	Phone	E-mail
General Information	Energy Call Center	800-555-7794 Toll Free 916-654-4058 Outside Calif.	CallCntr@energy.state.ca.us
Existing Technologies Account	Tony Goncalves	916-654-5168	TGoncalv@energy.state.ca.us
Emerging Technologies Account	Sanford Miller	916-653-2834	SMiller@energy.state.ca.us
New Technologies Account	Suzanne Korosec	916-654-4516	SKorosec@energy.state.ca.us
Customer Credit Account	Heather Raitt	916-654-4735	HRaitt@energy.state.ca.us
Consumer Education	Ann Peterson	916-653-4246	APeterso@energy.state.ca.us
Renewable Supplier/Providers Registration Program	Rasa Dale	916-654-5379	RDale@energy.state.ca.us
Power Content Label	Cheri Davis	916-657-4394	CDavis@energy.state.ca.us

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E-mail us about our Web Site at: energia@energy.ca.gov
"Energia" means ENERGY in Greek and Latin.



\$20 million will be saved by Vermont companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.

More ENERGY STAR Facts

- Vermont is home to 46 companies and public entities participating in ENERGY STAR partnerships.
- Nearly 5 million square feet of Vermont building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership.
- 2 ENERGY STAR-Labeled Product manufacturers are located in Vermont.
- Investments already made through the ENERGY STAR program in Vermont will prevent over 570 million pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 78,000 acres of trees — an area 200 times the size of the University of Vermont.
- Nitrogen oxide (NO_x) emissions will be reduced by 274,000 pounds and sulfur dioxide (SO₂) by 710,000 pounds due to existing ENERGY STAR investments in Vermont.

Highlights

- Vermont Star Homes received the ENERGY STAR Best Promotions Award for Most Creative Use of Media in 1998.

Market Potential

- Vermont has 170 million square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$42 million would be saved annually
 - The following emissions would be prevented each year:
 - 1 billion pounds of CO₂
 - 1.5 million pounds of NO_x
 - 4 million pounds of SO₂

VERMONT

ENERGY STAR Participants in Vermont



Baby Cakes, Inc.	Pan Handler Products
Brass Lantern, Inc.	Powerline Communications
Burlington Public Schools	REAP
Catalyst Financial Group	Robert E. Rainford
Chester Chamber of Commerce	Seventh Generation, Inc.
Eastern Energy Services, Inc.	Shire Inn
Federated Garden Club of Vermont	Shoreham Inn and Country Store
Green Mountain College	Somerset House B&B
Green Mountain Power Corporation	St. Albans Vermont Chamber of Commerce
Hawk Inn & Mountain Resort	State of Vermont
Jay Peak Ski And Summer Resort	Sugar Tree, A Country Inn
Judiths Garden B&B	Town & Country Motor Lodge
Land Works	Trails End, A Country Inn
Moose Hallow General Store	Tulip Tree Inn
Manchester Highland Inn	Vermont Army National Guard (State\Fed Space Included)
Mendon Mt. Orchards	Vermont Businesses for Social Responsibility
Middlebury College	Vermont Law School
Middlebury Student Government Association	Vermont Stresskin Panels
Molly Store Inn	Vermont Student Environmental Program
NHC, Incorporated	Village Inn at Woodstock
Nat Council of State Garden Clubs, New England Region	White House of Wilmington
Northshire Bookstore	Willard Street Inn
Norwich University	Ye Olde England Inn

Examples of Vermont Partners Saving Money and Helping the Environment

Burlington Public Schools, Burlington

- Saving \$132,000 in annual energy costs, \$0.21 per sq. ft.
- Upgraded lighting in over 620,000 sq. ft.
- Reducing energy use by 1.3 million kWh annually
- Preventing 1.8 million pounds of CO₂ annually

Vermont Army National Guard, Colchester

- Saving \$7,800 in annual energy costs
- Upgraded lighting in over 132,000 sq. ft.
- Reducing energy use by 88,000 kWh annually
- Preventing 149,000 pounds of CO₂ annually
- Committed to upgrading lighting in an additional 650,000 sq. ft.

Green Mountain Power Corp., South Burlington

"Collaborating with companies participating in energy efficiency upgrade programs enables both Green Mountain Power and its clients to financially benefit."

— Green Mountain Power

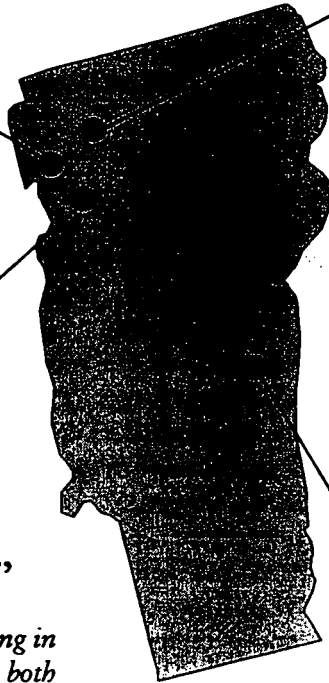
- Saving \$12,000 in annual energy costs
- Upgraded lighting in 162,500 sq. ft.
- Reducing energy use by 162,000 kWh annually
- Preventing 266,000 pounds of CO₂ annually
- Exploring additional whole-building energy efficiency upgrades

Vermont Law School, South Royalton

"We began [our energy efficiency program] about four years ago through incentives from our local utility. When I heard about the Green Lights program, I thought, why not?"

— John Delemarre, Physical Plant Director

- Saving \$30,000 in annual energy costs
- Upgraded lighting in 123,000 sq. ft.
- Reducing energy use by 270,000 kWh annually
- Preventing 292,000 pounds of CO₂ annually



EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Vermont



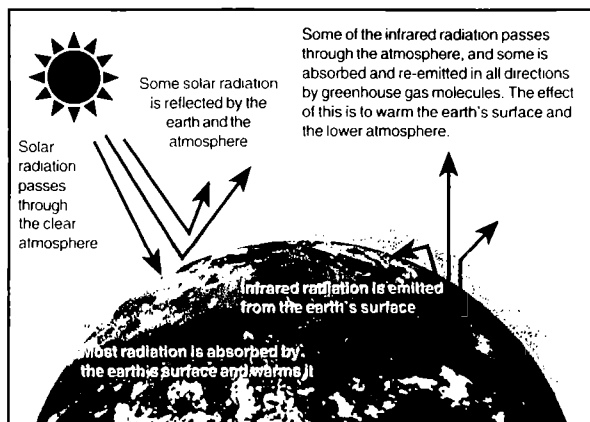
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

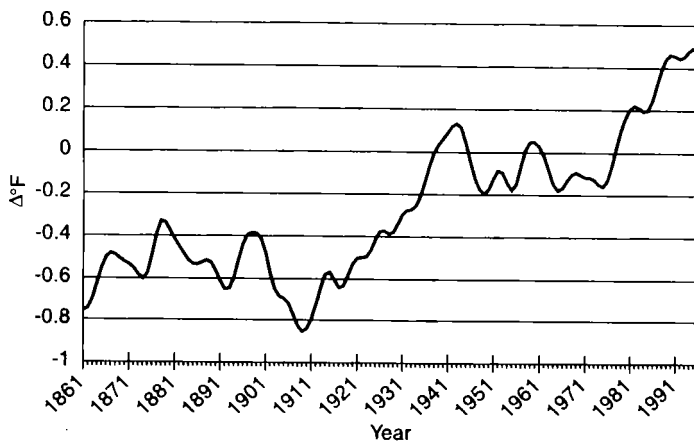
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as

well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

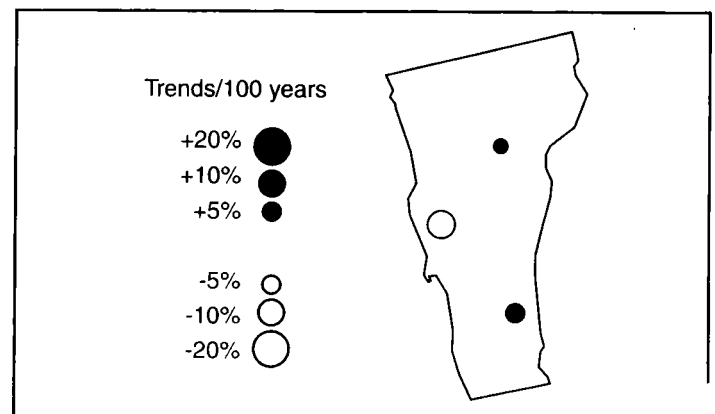
Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in Burlington, Vermont, has increased 0.4°F, and precipitation has increased by up to 5% in many parts of the state. These past trends may or may not continue into the future.

Over the next century, Vermont’s climate may change even more. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Vermont could increase by 4°F (with a range of 2-9°F) in spring and 5°F (with a range of 2-10°F) in the other seasons. Precipitation is projected to show little change in spring, to increase by about 10% in summer and fall (with a range of 5-20%), and by 30% (with a range of 10-50%) in winter. Other climate models show different results, especially regarding estimated changes in precipitation. The impacts described in the sections that follow take into account estimates from different models. The amount of precipitation on extreme wet or snowy days in winter is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. Although it is not clear how the severity of storms might be affected, an increase in the frequency and intensity of winter storms is possible.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. The elderly, particularly those living alone, are at greatest risk. These effects have been studied only for populations living in urban areas; however, even those in rural areas may be susceptible.

Climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. In New England, a 4°F warming, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by 4%. Although Vermont is in compliance with current air quality standards, increased temperatures could make remaining in compliance more difficult. Ground-level ozone is associated with respiratory illnesses such as asthma, reduced lung function, and respiratory inflammation. Air pollution also is made worse by increases in natural hydrocarbon emissions such as emissions of terpenes by trees and shrubs during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase. Respiratory and eye allergies increase in warm, humid conditions.

Warmer temperatures could increase the incidence of Lyme disease and other tick-borne diseases in Vermont, because populations of ticks, and their rodent hosts, could increase under warmer temperatures and increased vegetation.

Warmer winters, warmer temperatures, and heavy precipitation also can increase harmful algal blooms in lakes and ponds, reduce water quality, and increase outbreaks of cryptosporidiosis and giardia.

Water Resources

The eastern portion of Vermont is drained by the Connecticut River, which forms the border between Vermont and New Hampshire. The western half of the state is drained by tributaries that traverse the Green Mountains and flow into Lake Champlain and the Hudson River. These surface waters provide water for half of the state's population, are an important source of water for industry and hydroelectric generation, and support recreation uses. Winter snow accumulation and spring snowmelt strongly affect all the state's rivers. A warmer climate would lead to an earlier snowmelt, resulting in higher streamflows in winter and spring and lower streamflows in summer and fall. Warmer summer temperatures and longer summers could exacerbate water quality problems such as excessive growth of aquatic weeds in Lake Champlain and other lakes. Warmer water temperatures also reduce dissolved oxygen levels, adversely affecting fish habitat, and lower summer streamflows could reduce the ability of rivers to assimilate waste. Changes in the timing and accumulation of snow could affect skiing conditions in positive and negative ways, such as the timing and length of season and snow depth.

Increased rainfall could result in localized flooding and exacerbate levels of pesticides and fertilizers in runoff from agricultural lands, major causes of degraded water quality in Vermont. Less rainfall, particularly during the summer when temperatures and evaporation are high, could reduce streamflow, lake levels, and groundwater levels. This could reduce water supplies for those areas of the state experiencing the highest rates of growth, including Chittenden, Rutland, Washington, and Windsor counties. Declining aquifers would also affect small municipalities and rural populations that depend on wells.

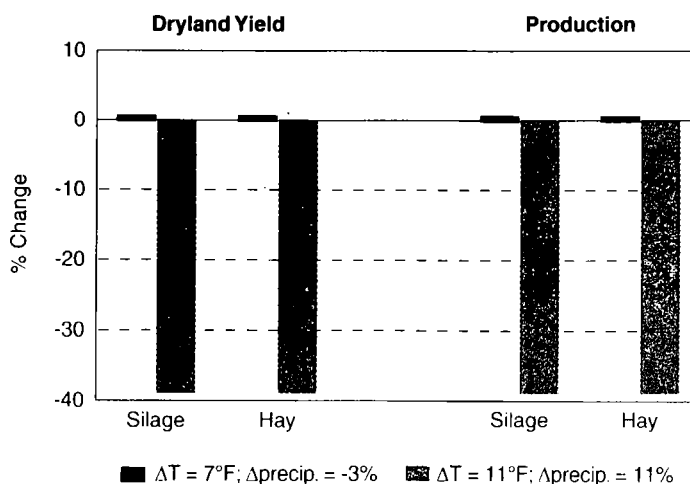
Lower water levels in freshwater lakes such as Lake Champlain would reduce flood damage, but shorelines could be more susceptible to erosion from wind and rain.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other users.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, crop pests, changes in air pollution such as ozone, and adaptation by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

Changes In Agricultural Yield And Production



Sources: Mendelsohn and Neumann (in press); McCarl (personal communication)

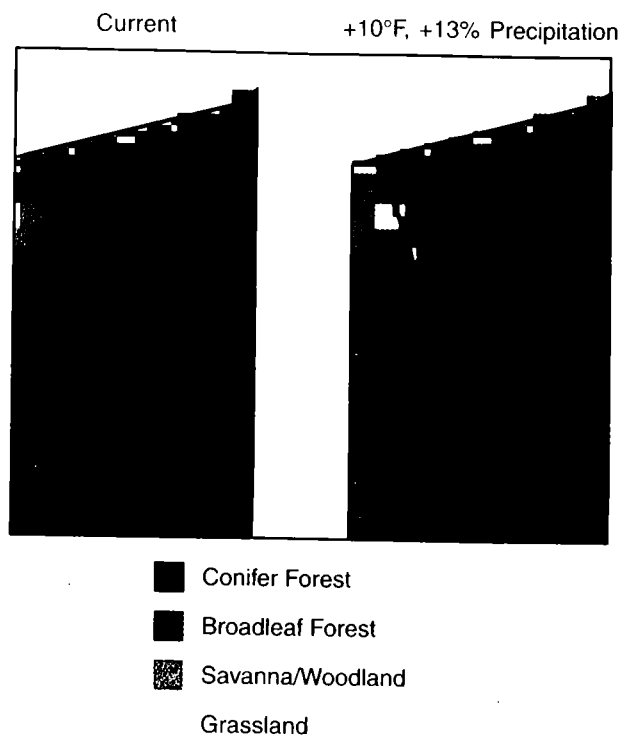
In Vermont, production agriculture is a \$440 million annual industry, three-fourths of which comes from livestock, mainly dairy operations. Very few of the farmed acres are irrigated. The major crops in the state are silage and hay. Yields of these crops and pasture could fall by as much as 39% under severe conditions as temperatures rise beyond the tolerance levels of the crop and are combined with increased stress from decreased soil moisture. The extent of farmed acres, however, is projected to remain fairly constant. Estimated changes in yield vary, depending on whether land is irrigated. Livestock and dairy production may not be affected, unless summer temperature rises significantly and conditions become significantly drier. Under these conditions, livestock gain less weight and pasture yields decline, limiting forage.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species composition, geographic range, and health and productivity. If conditions also become drier, the current range of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to warmer conditions, such as oak, hickory, and pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if the change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

Although the extent of forested areas in Vermont could change little because of climate change, a warmer climate could change the character of those forests. Maple-dominated hardwood forests could give way to forests with more oaks and conifers, species more tolerant of higher temperatures. This change would diminish the brilliant autumn foliage as the number of maple trees declines. The spruce-fir forests in Vermont (and other New England states) are near the southern limit of their extent. These forests are sensitive to climatic stresses and have experienced significant declines in recent decades. Across the state, as much as 30-60% of the hardwood forests could be replaced by warmer-climate forests with a mix of pines and hardwoods. The extent and density of the spruce and fir forests at higher altitudes and in the north, which support a large variety of songbirds, also could be reduced. The change in temperature also could cause maple sap to run earlier and more quickly, thus shortening the length of the season for gathering sap.

Changes In Forest Cover



Sources: VEMAP Participants (1995); Neilson (1995)

Ecosystems

Seven endangered animals and plants are found in Vermont, including the Indiana bat, the dwarf wedge mussel, and Jessup's milk vetch. These animal and plant populations could be further stressed by changes in climate and habitat. Higher-than-normal winter temperatures could boost temperatures inside cave bat roosting sites, which has been shown to cause higher mortality due to increased winter body weight loss in endangered Indiana bats (e.g., an increase of 9°F during winter hibernation has been associated with a 42% increase in the rate of body mass loss). The marshes of the Missisquoi River delta on the northeastern shore of Lake Champlain support hundreds of species of waterfowl, which depend on the water and marsh habitat. Climate change could alter the water balance and affect the health and range of the marshlands.

As forests change in both range and composition, the habitat that supports the mixture of plants and animals changes. Animal species specific to cooler conifer forests, such as spruce grouse, gray jays, moose, and marten, could experience moderate to severe range reductions. Waterfowl and other migratory birds could be especially vulnerable to climate change-induced shifts in the timing that food resources become available. If wetlands are reduced by a drier climate or increased frequency of droughts, waterfowl populations also could decline.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460, or visit <http://www.epa.gov/globalwarming/impacts>.



Climate Change Solutions



Vermont Trims Energy Bills for Low-Income Families

The Vermont Energy Investment Corporation, a nonprofit organization, has developed a number of innovative financing arrangements and partnerships to help low- and moderate-income Vermonters reduce their energy bills.

When less energy is used, fewer fossil fuels are burned. The combustion of fossil fuels produces carbon dioxide, an important atmospheric gas that is increasing in concentration and contributing to global climate change.

Working with the state housing finance agency and other public and private partners, the Vermont Energy Investment Corporation (VEIC) has cut energy use in low-income multifamily buildings, helped low- and moderate-income Vermont homeowners make energy efficiency improvements, and led a successful effort to establish a city ordinance on energy efficiency for residential rental units.

Removing Barriers to Efficiency

Energy costs can place a significant burden on low-income families. In Vermont, at least 15 percent of the annual budget of an average low-income family

goes to pay winter heating bills. Nationwide, households receiving Aid for Families with Dependent Children spend an average of 26 percent of their total income on electricity and other energy such as fuel for home heating. In comparison, the average family in the United States spends only 3.8 percent of its total income on energy.¹

Improving the energy efficiency of low-income housing could make life better for millions of Americans while reducing greenhouse gas emissions and other energy-related pollution.

Building owners often are reluctant to invest in energy upgrades. They may lack capital for the upfront expense of energy improvements, preventing them from making even the most cost-effective upgrades. They also may lack the energy expertise to ensure that their investments will provide a reasonable and timely return. In rental housing, short-term tenants are unlikely to make energy and efficiency upgrades because they may not remain in the housing long enough to enjoy the benefits. Owners of rental housing have no direct incentive to invest in energy efficiency if their tenants pay the energy bills.



Pipelitter Bob Fitzgerald solders a connection in a new high-efficiency gas-fired water-based heating system at a 51-unit senior citizen home in Burlington, Vermont.

VEIC has focused much of its work on removing barriers to energy efficiency. The organization provides financing, technical

RESULTS AT A GLANCE

- Working with public and private partners, the Vermont Energy Investment Corporation (VEIC) implemented energy efficiency measures in nearly 100 low-income multifamily buildings.
- Energy efficiency measures installed in 20 low-income multifamily housing projects in 1997 will save 416 megawatt-hours of electricity, 465 therms of natural gas, and \$53,000 per year in energy costs—resulting in carbon dioxide (CO₂) emission reductions of over 33 tons per year.
- Since 1986, Vermont's Home Energy Improvement Loan program, established by VEIC and the Vermont Housing Finance Agency, has provided more than \$800,000 in

energy loans to 180 Vermont households. Energy savings in those single-family homes averaged 20 percent or about \$350 per year.

- VEIC has performed more than 3,000 home energy ratings that allow Vermont homeowners to qualify for a mortgage or obtain financing for energy improvements.
- VEIC led a successful effort to establish a city ordinance that requires residential rental properties in Burlington to be brought to a minimum standard of energy efficiency when they are sold to a new owner. The ordinance is expected to reduce energy-related CO₂ emissions from rental units by an estimated 3,300 tons per year once it has been in place for 10 years.

expertise, reliable information, and direct installation of measures to facilitate efficiency upgrades and investments in buildings.

The State's Role

A key to VEIC's success is its long-standing partnership with the Vermont Housing Finance Agency, a state agency, which has worked with VEIC to develop home energy improvement loans, energy efficient mortgages, and other innovative programs. The housing finance agency also has been a source of capital for some of VEIC's loans and performance contracts.

Although the Vermont Housing Finance Agency cannot control most factors affecting housing costs (e.g., land prices, construction costs, and the cost of capital), the agency has long recognized that it can help control energy costs. The housing finance agency has played an active role in lowering the energy bills of low- and moderate-income Vermonters.

All 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands have housing finance agencies similar to Vermont's. State housing finance agencies act as secondary mortgage buyers to promote affordable housing for low- and moderate-income people.

Improving Energy Efficiency in Multifamily Low-Income Housing

In VEIC's work with multifamily low-income housing, it operates as an energy services company (ESCO), entering into long-term relationships with building owners to implement energy efficiency measures. Through performance contracting (see box), VEIC assumes the financial risk for its projects and is paid out of the resulting energy cost savings. By

eliminating the client's risk and need for upfront capital, VEIC removes two major barriers to investments in energy efficiency.

As a nonprofit organization, VEIC's mission is to save energy. "We are interested only in covering our costs, not generating a profit," says VEIC Executive Director Beth Sachs. This allows VEIC to fill a void left by commercial ESCOs, which generally are unwilling to take on smaller projects or those where the profit margins may be unacceptably low.

At least 15 percent of the annual budget of an average low-income Vermont family goes to pay winter heating bills.

An Attractive Opportunity

Performance contracting for energy efficiency improvements is especially attractive to local public housing authorities, according to Sachs. The U.S. Department of Housing and Urban Development (HUD) provides an incentive to public housing authorities to use performance contracting for energy efficiency improvements by "freezing" the annual subsidy paid to the housing authority for utility costs. The subsidy is frozen at the levels used prior to the installation of energy improvements, which allows the public housing authority to retain the cost savings for up to 12 years. The housing authority can then pay the debt service for the energy improvements and the newly reduced utility bills out of the subsidy.

Once the performance contract is completed, HUD lowers the subsidy needed by the housing authority to cover the new energy bills, and the cost of operating the housing is reduced permanently. The only condition is that the new energy costs plus the debt service must be the same as or less than the old energy bills. "This is a window of opportunity for public housing, and housing authorities should be jumping on it now," Sachs says.

Innovative Financing

In the late 1980s and early 1990s, the Vermont Housing Finance Agency launched programs to help owners of subsidized multifamily housing boost the energy efficiency of their buildings. Most of the financing for these programs comes from "project cost escrow funds," which are monies set aside at the time of the initial financing to be used 7-12 years after purchase of the building for necessary repairs and enhancements.

Before property owners can spend their project cost escrow funds, the Vermont Housing Finance Agency requires an energy audit. If the audit reveals cost-effective opportunities for energy efficiency investments such as improved insulation and heating equipment, the owners are encouraged to make those investments and to use the energy savings to pay for repairs, painting, or other improvements. In other words, Sachs says, "They get to spend the project cost escrow money twice to improve the property."

The Vermont Housing Finance Agency also works with multifamily property owners to take advantage of other funding sources—such as surplus operating income, increased cash flow from refinancing, and the agency's own capital—to improve energy efficiency.

Performance contracting for energy efficiency improvements is especially attractive to local public housing authorities, according to Sachs. The U.S. Department of Housing and Urban Development (HUD) provides an incentive to public housing authorities to use performance contracting for energy efficiency improvements by "freezing" the annual subsidy paid to the housing authority for utility costs. The subsidy is frozen at the levels used prior to the installation of energy improvements, which allows the public housing authority to retain the cost savings for up to 12 years. The housing authority can then pay the debt service for the energy improvements and the newly reduced utility bills out of the subsidy.

Improving Energy Efficiency in Single-Family Housing

Faced with a shortage of capital and a lack of financing opportunities, many homeowners cannot afford to improve the energy efficiency of their homes. To rectify this situation, the Vermont Housing Finance Agency and VEIC established Vermont's Home Energy Improvement Loan Program, which offers affordable loans to low- and moderate-income homeowners for energy investments. The program, created in 1986 and now being implemented by the Vermont Development Credit Union, offers low interest rates and loan terms of up to seven years. Energy costs and anticipated savings can be included when calculating debt-to-income ratios, which allows energy savings to be credited to the "income" side of the ratio when determining a purchaser's eligibility for financing energy improvements.

Since its inception, the program has provided more than \$800,000 in energy loans to 180 Vermont households. Energy savings averaged 20 percent.

Innovative Mortgage Products

The Vermont Housing Finance Agency provides affordable mortgages for 15-20 percent of the existing and new homes bought each year in the state. Many of these sales have involved VEIC's Energy Rated Homes of Vermont program, allowing energy efficiency to be incorporated into the mortgage process.

For low-income and first-time buyers of existing homes, VEIC worked with the Vermont Housing Finance Agency to develop the Yearly Energy Savings System (YESS) Mortgage Program, which offers a reduced mortgage interest rate to eligible homebuyers who make energy improvements at the time of purchase.

To ensure that low-income and first-time buyers of newly constructed homes will not be burdened by future high energy bills, the Vermont Housing Finance Agency requires that the home receive an energy rating of at least "4 Stars." A home energy rating is a standard measure of a home's efficiency, much like mileage ratings for cars. The ratings allow homebuyers to compare the energy efficiency of one house to

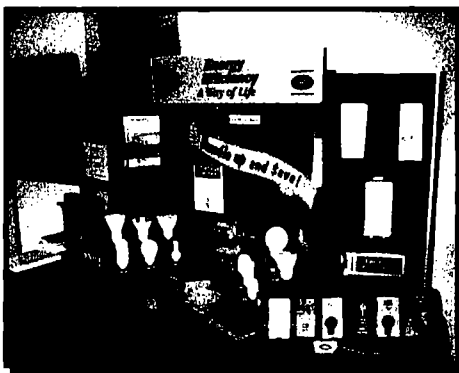
another in order to estimate future energy bills. Homes are rated from 1 Star to 5 Stars, with 4 Stars or higher considered energy efficient.

Vermont also offers "energy-efficient mortgages" to help all families (not just low-income) buy better homes and lower their energy costs. In Vermont, a home that earns an energy rating of 4 Stars or more is eligible for an energy-efficient mortgage, which allows consumers to qualify for homes that might otherwise be unaffordable. The energy rating assures the lender that the energy-efficient home's lower heating and electricity bills will free up money that the household can use to meet the higher monthly mortgage payment of a more expensive home.

Energy ratings below 4 Stars can be used to obtain "energy-improvement mortgages," which allow home buyers to finance the cost of energy improvements through larger mortgages. The improvements are tax-deductible because they are included in the loan, and the monthly savings in energy costs must exceed the additional amount of the mortgage.

Addressing the "Split Incentive" in Rental Units

Rental housing creates what energy analysts call a split incentive: tenants are unlikely to pay for energy efficiency improvements, and owners have little direct incentive to do so if the tenants pay the energy bills. As a result, renters often bear the burden of trying to stay warm in dwellings that are poorly insulated and expensive to heat.



A display in the Burlington Electric Department's lobby shows some of the ways Burlington residents can save energy.

Burlington is one of the coldest metropolitan areas in the United States and ranks among the top 10 percent of cities in fuel use per capita. More than half of Burlington's homes were built before 1939. In the city's Old North End, where most rental housing is located, 70 percent of the homes are more than 50 years old. Low-income residents there often find that they pay more for energy than for any other items in their household budgets, except food and rent.

To overcome this problem, VEIC led an effort with support from the U.S. Environmental Protection Agency's State and Local Climate Change Program to establish a city ordinance that requires residential rental property in Burlington to be brought up to a minimum standard of energy efficiency at the time of property transfer. This time-of-sale ordinance, which went into effect in September 1997, is designed to lower tenants' energy costs while minimizing costs to the property buyer or seller.

A Win-Win Proposition

Property owners can benefit from the ordinance in a number of ways. The average tenant in Burlington stays in an apartment for only one year, and over half of the frequent movers who were surveyed cite unaffordable energy bills as a primary reason for moving. With lower energy costs, tenants may stay longer. Building owners not only keep their rental units occupied, they also may gain from efficiency improvements that help alleviate property maintenance issues such as moisture and mildew, peeling paint, and roof damage from ice dams.

The costs of energy improvements could be passed on to tenants through higher rents, but any increase is expected to be offset by lower energy costs. VEIC's conversations with officials in communities with existing energy ordinances for rental units (in Wisconsin, Minnesota, and California) suggest that the ordinance should have little impact on rents compared with market forces.

The Burlington ordinance will require that an energy inspection be performed on rental properties before they are sold. A certificate of compliance, a stipulation

that work will be done to meet the standard, or an application for a waiver must be filed with the city clerk. Either the seller or the buyer may bring the property into compliance. A buyer who agrees to take responsibility has one year from the filing date to comply. The ordinance includes cost limitations and exemptions to avoid placing an undue burden on property owners.

The Burlington Electric Department administers the ordinance and offers information on financing, technical assistance, and other services to help rental unit owners comply with the ordinance and go beyond its minimum requirements.

The ordinance is being phased in over time. At present, it applies only to the Old North End Enterprise Community, and it will be expanded to all of Burlington in two years after a report is given to the city council.

VEIC estimates that the ordinance will reduce energy-related CO₂ emissions by 3,300 tons per year once it has been in place for 10 years.

"This is an area where public policy intervention was important because needed improvements were not getting made as a result of market forces," Sachs observes. "The challenge now is to encourage owners to go beyond the minimum required to meet the standard and implement optimum, cost-effective improvements in their properties."

Lessons Learned

Emissions can be reduced without affecting low-income families disproportionately. VEIC's work is helping make energy more affordable for low-income residents of Burlington and other Vermont communities. It also contributes to municipal and state goals for reducing greenhouse gas emissions.

Energy audits are just the beginning

"Energy audits alone don't save energy or empower people," Sachs observes. VEIC's work grew out of experiences that Sachs and co-founder Blair Hamilton had when they talked to people who had received energy audits. They discovered that few building

owners actually implement the efficiency measures recommended as a result of the audit process because they lack access to capital.

Barriers can be overcome

Sachs and Hamilton realized that the main obstacles to investing in energy efficiency are a lack of capital and trustworthy advice. By providing a one-stop shop for financing, technical expertise, and reliable information, VEIC has helped multifamily building owners, private homeowners, and others overcome these barriers to reduce their energy bills. VEIC has built a reputation as a trustworthy provider of services, based on its nonprofit status and its track record of cutting energy costs.

Greenhouse gas emissions can be reduced without having a disproportionate impact on low-income families.

VEIC's work can be replicated in other states

According to Sachs, VEIC's approach could be replicated by states and municipalities throughout the nation. Others could achieve results similar to VEIC's by establishing partnerships among community action agencies, community development corporations, county planning organizations, state and municipal agencies, and other organizations.

Looking Ahead

VEIC is now preparing for electricity deregulation by creating a statewide energy co-operative that will provide customers with environmentally sustainable energy at affordable costs.

"The idea is not to lower customers' rates, but to lower their bills," Sachs says. The co-op would package energy services along with the energy supplied, helping customers slash their energy bills through energy efficiency measures. Although the co-op's reliance on

"green" power might make its rates slightly higher than those of its competitors, customers' bills would be lower because their homes would use less energy.

For More Information

Vermont Energy Investment Corporation

255 South Champlain Street
Burlington, VT 05401-4717

Tel: (802) 658-6060; Fax: (802) 658-1643

E-mail: beth@veic.org

<http://homepages.together.net/~veic>

Vermont Housing Finance Agency

P.O. Box 408

Burlington, VT 05402

Tel: (800) 287-8432 (toll-free)

Fax: (802) 864-8081

E-mail: home@vhfa.org

<http://www.vhfa.org>

State and Local Climate Change Program

U.S. Environmental Protection Agency

401 M Street, SW (2171)

Washington, DC 20460

Tel: (202) 260-3354

Fax: (202) 260-0290

<http://www.epa.gov/globalwarming/actions/state>

U.S. Department of Energy's

Rebuild America program:

www.eren.doe.gov/buildings/rebuild

U.S. Environmental Protection Agency's

Energy Star programs:

<http://www.epa.gov/energystar>





Climate Change Mitigation in Vermont

Vermont's Greenhouse Gas Emissions (1990)¹

- Total greenhouse gas emissions in 1990 were about 2 million metric tons of carbon-equivalent, less than 1% of the U.S. total for that year.
- Per capita emissions for 1990 were about 3.6 metric tons, lower than the 1990 national average of 5.3.
- The major source of greenhouse gas emissions in Vermont was transportation, which accounted for about 41% of all emissions.
- The second highest source of greenhouse gas emissions in Vermont was residential, accounting for 35% of emissions, followed by industrial, which accounted for about 12% of emissions.

Mitigation Policy Planning:

- In 1998, the Vermont Department of Public Service completed *Fueling Vermont's Future: Comprehensive Energy Plan and Greenhouse Gas Action Plan*. The report identified a list of options that would:
 - reduce emissions 21%,
 - reduce total energy use by 16.2%,
 - improve employment 1% cumulatively,
 - reduce acid rain precursors by 21.4%,
 - reduce ground level ozone precursors by nearly 30%, and
 - save over \$12 billion dollars in costs and emissions by 2010.

The box below lists the policies recommended the report²

Policies Recommended in Vermont

Residential:

- Improve efficiency and indoor air quality in new homes

Commercial:

- Increase efficiency in new construction

Transportation:

- Increase efficiency of vehicles (via enforcement of highway speed limits and adoption of 55MPH on interstate speed limits)
- Reduce VMTs: promote Bus, vanpools, and trains; encourage non-motorized transportation, encourage telecommuting, encourage high-density, mixed land-use planning, pay-at-the-pump auto liability insurance.
- Reduce transportation-related emissions: use vapor recovery at gas stations, adopt low emissions vehicle standards
- Transportation taxation and energy taxation: motor fuels tax

Electricity generation:

- Promote wood energy: promote new stoves, replace Yankee Power with Wood gasification and wind power
- Support hydro and methane as sources: Increase use
- Use energy taxation with revenue recycling: Carbon tax (\$100/ton) with revenue to taxpayers, elimination of sales tax exemption on motor fuels with revenue to taxpayers, gross fuel receipts tax with revenue to weatherization

Total greenhouse gas savings: 53.3 MSTCDE (21.4%)

Target date: 2020

Total Cost savings: \$12.2 billion

Sample of existing Vermont policies that reduce greenhouse gas emissions³:

- Promote clean, efficient, wood burning with new stoves
- Increase appropriate use of landfill methane energy

- Increase appropriate use of farm methane energy
- Encourage non-motorized transportation
- Telecommuting
- Land use planning
- Model Energy Codes in residential new construction
- Commercial new construction and retrofit policies
- Portfolio standard requiring generation to come from renewables
- System Benefit Charges

Benefits of Reduced Reliance on Fossil Fuels: Increased opportunities for Vermont

Increases in renewable energy use and energy efficiency improvements would provide new economic opportunities for many industries. Some states already reap significant benefits from reduced reliance on fossil fuels. For example, 33% of all U.S. solar collector shipments, valued nationally at \$29.8 million in 1996 (EIA Renewable Energy Outlook 1997), originated in California. Similar industries in Vermont could experience gains from a shift away from fossil fuels.⁴

Wind-related Products and Services in Vermont:

- Atlantic Orient Corporation in Norwich, New World Power Corporation in Waitsfield, NRG Systems in Hinesburg, and Windstream Power Systems Inc. in Burlington.

Solar- and PV-related Products and Services in Vermont:

- BPVS in Stamford, Gentle Energy Systems Inc in Charlotte, Independent Power & Light in Hyde Park, Maximum RGB in Wallingford, S and H Alternative Energy in Putney, Solar Applications in Brattleboro, Solar Works, Inc. in Montpelier, South Face Design & Construction in Brownsville, Sustainable Solutions in Plainfield, Vermont Custom Heating Inc in Charlotte, Vermont Energy Cointracting & Supply Corp in Burlington, Vermont Solar Engineering in Burlington, and Windstream Power Systems Inc. in Burlington.

Energy efficiency-related Products and Services in Vermont:

- Environmental Building News in Brattleboro, Green Mountain Technologies in Whitingham, and S and H Alternative Energy in Putney.

Win-Win Climate Mitigation Projects in Vermont⁵

The City of Burlington and the State and Local Climate Change Program

- As a participant in the Cities for Climate Protection Campaign, Burlington has committed to conducting an emissions inventory, to adopting an emissions reduction target, and to implementing a strategy to achieve their target.

NOTE: This compilation is a work in progress. For comments, corrections, questions, or additions, please contact Denise Mulholland of the U.S. EPA State and Local Climate Change Program at 202-260-4005 or mulholland.denise@epa.gov.

¹ Source: *Fueling Vermont's Future: Comprehensive Energy Plan and Greenhouse Gas Action Plan*, Vermont Department of Public Service, July 1998.

² Source: Ibid.

³ Sources: *The Green Power Network*, U.S. Department of Energy EREN, www.eren.doe.gov/greenpower, October 5, 1998; *Renewable Energy Sourcebook: A Primer For Action*, Public Citizen, www.citizen.org/CMEP/renewables, June 1998; *Database of State Incentives for Renewable Energy*, North Carolina Solar Center and Interstate Renewable Energy Council (IREC), www-solar.mck.ncsu.edu, May 1998;

⁴ *The Source for Renewable Energy*, <http://www.sourceguides.com/energy/businesses>, October 1998.

⁵ *U.S. Communities Acting to Protect the Climate: A Report on the Achievements of ICLEI's Cities for Climate Protection - U.S.*, International Council for Local Environmental Initiatives, November 1997; EPA Program Managers as of November 1997. For further information, please see www.epa.gov/globalwarming.



\$88 million will be saved by Iowa companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



IOWA

More ENERGY STAR Facts

- Iowa is home to 28 companies and public entities participating in ENERGY STAR partnerships.
- Over 76 million square feet of Iowa building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 850 times the size of the Capitol Building.
- Investments already made through the ENERGY STAR program in Iowa will prevent 2 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 307,000 acres of trees — an area over 25 times the size of Iowa State University.
- Nitrogen oxide (NO_x) emissions will be reduced by 8 million pounds and sulfur dioxide (SO₂) by 17 million pounds due to existing ENERGY STAR investments in Iowa.

Highlights

- Maytag received the ENERGY STAR Labeling and Retail Appliance Leadership Award in 1999.
- Amana received the ENERGY STAR HVAC Certificate of Distinction in 1996.

Market Potential

- Iowa has 840 million square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$193 million would be saved annually
 - The following emissions would be prevented each year:
 - 5 billion pounds of CO₂
 - 28 million pounds of NO_x
 - 60 million pounds of SO₂

ENERGY STAR Participants in Iowa



Alcoa/Aerospace
Adventure Lighting Supply, Ltd.
Ag Risk Insurance
Casey's General Stores, Inc.
Century I & Century II Office
Buildings
Corkery Waste Disposal &
Recycling Services
Davenport Community School
District
Decorah Public Library
First Christian Church
HON Industries Inc.
Harlan Chamber of Commerce
Iowa Association of Business &
Industry
Iowa Hospital Association, Inc.
State of Iowa
Marshalltown Community
Schools
Maytag
Mercy Health Center
Midwest Power
Nichols Aluminum
Olberling Law Office
Prairie Woods
Principal Financial Group
Soil and Water Conservation
Society
Stamats Communications Inc
Stitzell Electric Company
Synergy Lighting Corporation
Iowa Army National Guard
Wittrock Financial

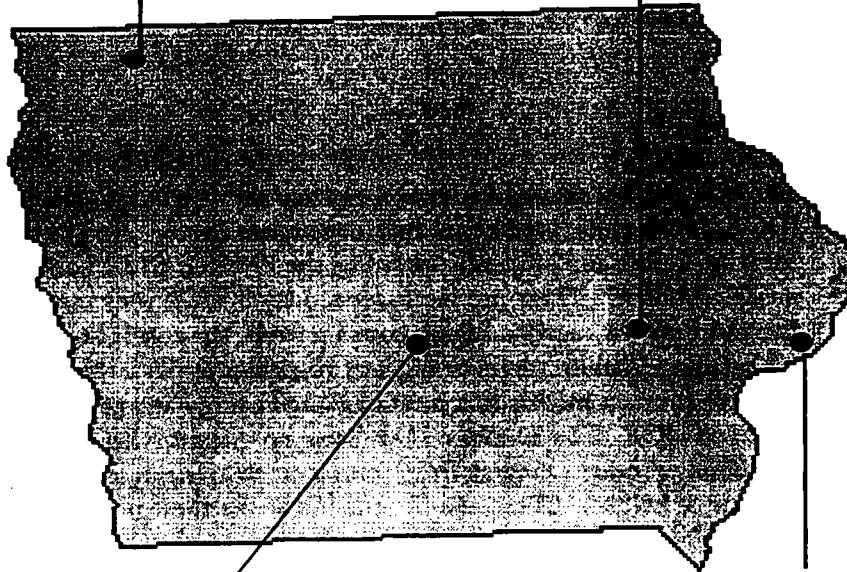
Examples of Iowa Partners Saving Money and Helping the Environment

Union Camp Corporation, Sibley

- Saving \$18,000 in annual energy costs
- Upgraded lighting for 250,000 sq. ft.
- Achieving internal rate of return of 24%
- Preventing 845,000 pounds of CO₂ annually
- As a whole, Union Camp saves more than \$11 million annually from upgrades made to 18.5 million sq. ft.

Gillette, Iowa City

- Saving \$4,000 in annual energy costs
- Upgraded lighting for 260,000 sq. ft.
- Reducing energy use by 81,000 kWh annually
- Preventing 163,000 pounds of CO₂ annually
- Pleases workers with better lighting levels and improved color rendering



Casey's General Stores, Ankeny

- Saving \$500,000 in annual energy costs
- Upgraded lighting in 800 stores plus headquarters
- Preventing pollution equal to planting 1500 acres of trees annually
- Publicized energy savings successes to employees in a newsletter article

Davenport Community School District

"Our participation in the [ESB/GL Partnership] is a very aggressive approach to saving money."

— Bill Good, Director of Support Services

- Saving \$240,000 in annual energy costs
- Upgraded lighting for 2.1 million sq. ft.
- Preventing 4.1 million pounds of CO₂ annually
- Ranks 11th nationwide in school districts for its pollution prevention

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Iowa



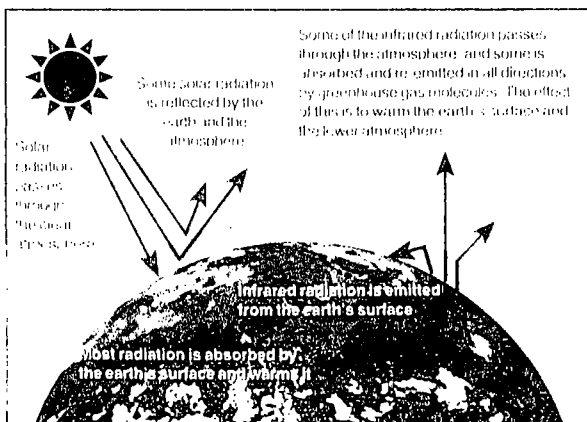
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today could not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

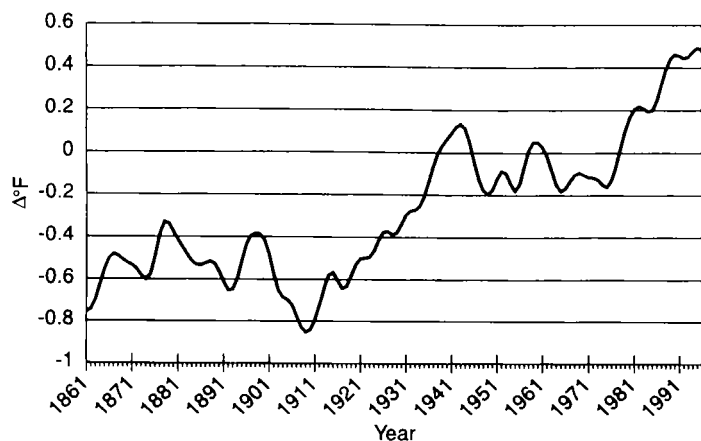
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming — such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

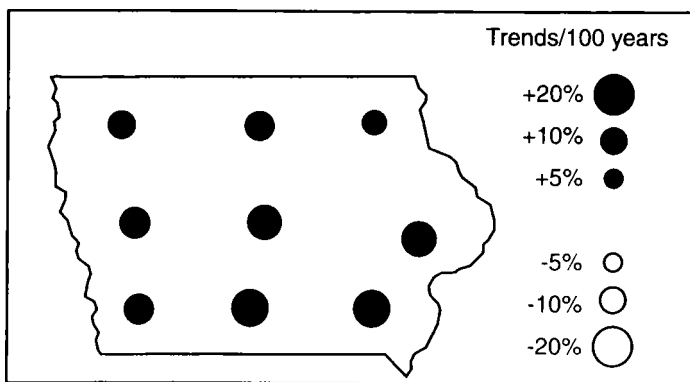
Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature near Des Moines, Iowa, has decreased 0.2°F, and precipitation has increased by up to 20% in many parts of the state. These past trends may or may not continue into the future.

Over the next century, climate in Iowa could experience additional changes. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Iowa could increase by 2°F in summer (with a range of 1-4°F), 3°F in spring (with a range of 1-5°F), and 4°F in fall and winter (with a range of 2-7°F). Precipitation is estimated to increase by 10% in winter and spring (with a range of 5-20%), 15% in fall (with a range of 5-30%), and 20% in summer (with a range of 10-40%). Other climate models may show different results, especially regarding estimated changes in precipitation. The impacts described in the sections that follow take into account estimates from different models. The frequency of extreme hot days in summer would increase because of the general warming trend. It is not clear how the severity of storms might be affected, although an increase in the frequency and intensity of summer thunderstorms is possible.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. The elderly, particularly those living alone, are at greatest risk. These effects have been studied only for populations living in urban areas; however, even those in rural areas may be susceptible.

Climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. A 2°F warming in the Midwest, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by as much as 8%. Although Iowa is in compliance with current ozone air quality standards, increased temperatures could make remaining in compliance more difficult. Ground-level ozone is associated with respiratory illnesses such as asthma, reduced lung function, and respiratory inflammation. Air pollution also is made worse by increases in natural hydrocarbon emissions such as emissions of terpenes by trees and shrubs during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

Upper and lower respiratory allergies also are influenced by humidity. A 2°F warming and wetter conditions could increase respiratory allergies.

Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects. Infected individuals can bring malaria to places where it does not occur naturally. Also, some mosquitoes in Iowa can carry malaria, and others can carry California encephalitis, which can be lethal or cause neurological damage. If conditions become warmer and wetter, mosquito populations could increase, thus increasing the risk of transmission if these diseases are introduced into the area. Warmer temperatures could increase the incidence of Lyme disease and other tick-borne diseases in Iowa, because populations of ticks, and their rodent hosts, could increase under warmer temperatures and increased vegetation.

Increased runoff from heavy rainfall could increase water-borne diseases such as giardia, cryptosporidia, and viral and bacterial gastroenteritides. Developed countries such as the United States should be able to minimize the impacts of these diseases through existing disease prevention and control methods.

Water Resources

Iowa is bordered on the east by the Mississippi River and on the west by the Missouri River. Roughly two-thirds of the state drains to the Mississippi, and the western third drains to the Missouri. Along the major rivers, the largest water withdrawals are for thermoelectric power generation. In the central and northern parts of the state, groundwater is more important than surface water because these areas contain most of the population, and the principal use of groundwater is for public

supply. During most years, precipitation is sufficient to maintain streamflow, recharge aquifers, and preserve sufficient soil moisture to support agriculture (which is primarily rainfed). However, streamflow is highly variable, and during years with less-than-average precipitation, surface water supplies become critically deficient, particularly in the western and south-central areas of the state. This situation could be exacerbated in a warmer climate. Runoff in the state comes largely from rainfall, and to a lesser degree from snowmelt. Warmer winter temperatures would lead to earlier snowmelt and would increase streamflows in winter and spring. In the summer, without large increases in precipitation, higher temperatures and increased evaporation would reduce streamflows, lake levels, and groundwater levels. Lower streamflow and lake levels would limit important uses of the Mississippi and Missouri River reservoirs, including navigation, hydropower generation, recreation, wildlife conservation, and wastewater assimilation. Water availability also would be reduced for offstream uses such as thermoelectric power generation, supply for a growing population, and irrigation demand. In western Iowa, groundwater is used for irrigation during droughts and at critical times in the growing season. Groundwater also is used to water livestock throughout the state. Lower groundwater levels would adversely impact these agricultural uses, as well as public supplies. Lower flows and higher temperatures also could degrade water quality by concentrating pollutant levels and could impair wetlands.

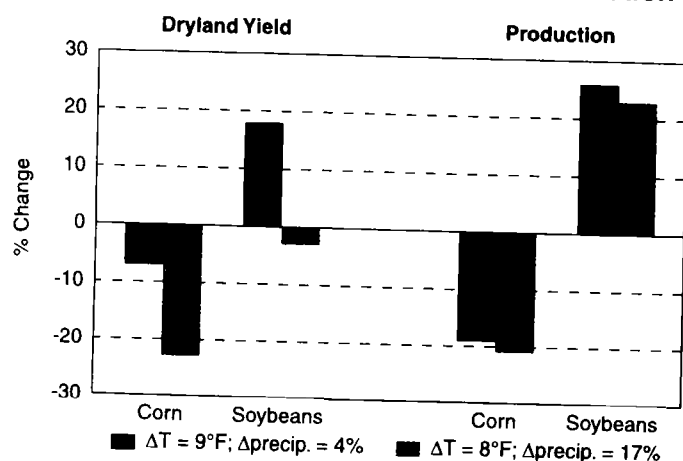
In Iowa, too much rain is as much a concern as too little. Many areas are susceptible to flooding, and the fertile soils in the state are highly erodible. Also, many soils have little permeability, and drainage is a problem. Surface-water quality problems are associated with sedimentation from soil erosion and with high concentrations of nitrates, pesticides, and nutrients from agricultural runoff. Increased rainfall would aggravate these problems, particularly because heavier rains are expected in a warmer climate.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other users.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, crop pests, changes in air pollution such as ozone, and adaptation by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

Changes In Agricultural Yield And Production



Sources: Mendelsohn and Neumann (in press); McCarl (personal communication)

In Iowa, production agriculture is a \$10 billion annual industry, 60% of which comes from livestock, mainly cattle. Very few of the farmed acres are irrigated. The major crops in the state are corn and soybeans. Corn yields could fall 7-23%, depending on the extent to which temperature rises beyond the tolerance level of the crop. Soybean yields could fall by 3% or, if changes are less severe, could rise by 18%. Farmed acres could remain fairly constant or could decrease by as much as 8%. Livestock and dairy production may not be affected, unless summer temperatures rise significantly and conditions become significantly drier. Under these conditions, livestock tend to gain less weight and pasture yields decline, limiting forage.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species composition, geographic range, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to warmer conditions, such as oaks and southern pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if the change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

In Iowa, less than 5% of the area is forested, mostly along rivers and streams. With changes in climate, the extent of forested areas in Iowa may change little or could increase by as much as 10-40%, depending on competition from agricultural uses. The uncertainties also depend on many other factors, including whether soils become drier and, if so, how much drier. With hotter, drier weather, southern pines gradually would replace deciduous forests in the southern part of the state, particularly in areas with rich soils. In areas with poorer soils, which are common in some Iowa forests,

scrub oaks of little commercial value (e.g., post oak and blackjack oak) could increase. In contrast, warmer, wetter conditions could expand northward the range of oak and pine forests and riparian woodlands.

Ecosystems

Iowa lies in a zone of transition between the forested ecosystems to the east and the Great Plains of the central United States. The natural heritage of the state includes hardwood forests in the south and east, the bluestem prairie in the northwest, and the elm-ash-cottonwood forests of the Mississippi tributaries. The Prairie Pothole Region, which extends into north-central Iowa, is a globally important resource for waterfowl and shorebirds. Millions of migratory birds use the Mississippi River corridor during fall and spring migration, which is critical because of its north-south orientation and its nearly uninterrupted habitat. Desoto National Wildlife Refuge, for example, is a temporary home for hundreds of thousands of snow geese and tens of thousands of ducks. Much of the state is intensively cultivated, and surface water systems receive substantial inputs of nutrients, pesticides, sediments, and pollutants. As a result, populations of fingernail clams, unionid mussels, submersed vegetation, mink, and migratory waterfowl have declined in recent decades. Many waterfowl populations have also declined recently; for example, mallard, blue-winged teal, and northern pintail are at or near their lowest numbers ever recorded. Along one of the reaches of the Mississippi in southern Iowa, peak numbers of lesser scaup have decreased from 300,000-500,000 in the 1970s to fewer than 25,000 today. The oak savannas of the transition zone between the vast treeless prairies and eastern deciduous forests now share equal billing with tallgrass prairie as one of the most threatened plant communities in the Midwest. Historically, they covered large parts of eastern and southern parts of the state, but today they have all but disappeared and are a globally endangered ecosystem. The estimated increases in temperature and changes in precipitation due to climate change could further stress these wildlife and plant resources.

Water and the resulting life that it brings is key to the prairie ecosystem. The abundance of wetlands is closely tied to the yearly variation in weather patterns, including variation in both precipitation and temperature. This has important implications for the shorebird migrants that funnel through the Great Plains. Under drier conditions, wetland feeding areas are not as abundant. As the quantity of suitable habitat declines, artificially high concentrations of waterfowl may lead to increased transmission of avian botulism and large-scale dieoffs. Species of the upland prairie also could face problems in a changing climate. For example, one study showed that all 23 grassland bird species would shift their range and approximately half would decline in range under projected climate change. Sprague's pipit and McCown's longspur could become extinct and chestnut-collared longspur and Baird's sparrow were highly vulnerable.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460, or visit <http://www.epa.gov/globalwarming/impacts>.



Climate Change Mitigation in Iowa

Iowa's Greenhouse Gas Emissions (1990)¹

- Total greenhouse gas emissions in 1990 were about 21 million metric tons of carbon-equivalent, about 2% of the national total for that year.
- Per capita emissions in 1990 were about 8 metric tons per person, higher than the 1990 national average of 5.
- The major source of fossil fuel-related emissions in Iowa is industry, accounting for about 38% of emissions.
- The second highest source of emissions in Iowa was transportation, responsible for 25% of emissions, followed by residential, at 22%.

Mitigation Policy Planning:

- In 1996, the Iowa Department of Natural Resources completed the *Iowa Greenhouse Gas Action Plan*. The plan identifies 16 cost-effective options that would save at least 4 MMTCE and reduce state energy costs up to \$300 million each year. They are currently conducting outreach and peer exchanges about climate change within the agricultural community.

The box below lists the policies recommended the report²

Policies Recommended in Iowa

Residential:

Energy efficiency improvements (via state and federal voluntary programs: Rebuild Iowa, Building Energy management Program, Energy Star Buildings, Green Lights)

Industrial & commercial:

Energy efficiency improvements (via state & federal voluntary programs: Climate Wise, Total Assessment Audit, Motor Challenge)

Emissions trading

Reporting facility greenhouse gas emissions

Transportation:

Energy efficiency improvements (revenue neutral fee/rebate)

Discourage single occupancy trips via economic incentives

Electricity generation:

Demand-side management

Production of energy crops

Wind power development (Renewable Portfolio Standards)

Emissions trading

Reporting facility greenhouse gas emissions

Forestry:

Tree planting programs

Agriculture:

Reducing N₂O from fertilizers (via demonstration and education projects)

Improved manure management (require methane recapture)

Continued improvement of farm efficiency

Total greenhouse gas savings: 15 MMTCE (X%)

Target date: 2010

Total Cost savings: Annual saving of \$300 million

Recommendation for Federal Action:

Adopt emissions allowance system

Sample of existing Iowa policies that reduce greenhouse gas emissions³:

- Net Billing
- Improvement of energy-efficiency in state buildings
- Tree planting initiatives

Benefits of Reduced Reliance on Fossil Fuels: Increased opportunities for Iowa

Increases in renewable energy use and energy efficiency improvements would provide new economic opportunities for many industries. Some states already reap significant benefits from reduced reliance on fossil fuels. For example, 33% of all U.S. solar collector shipments, valued nationally at \$29.8 million in 1996 (EIA Renewable Energy Outlook 1997), originated in California. Similar industries in Iowa could experience gains from a shift away from fossil fuels.⁴

Battery-related Products and Services:

- *Companies include:* Alexander Batteries in Mason City

Solar-related Products and Services:

- *Companies include:* Energy Alternatives Ltd in Oakland; Gs Energy Industries Inc in Des Moines; Havelka Construction (electric vehicle batteries, PV systems, renewable energy system batteries, Small wind turbines, PV module components) in Fairfield; Iowa Energy Savers in Woodbine; Natural Energy in Davenport; Solarium Sales Inc in Des Moines; and The Root Cellar in Dubuque.

Wind-related Products and Services:

- *Companies include:* J. P. Sayler & Associates, Consultants Ltd. In Des Moines and The Root Cellar in Dubuque

NOTE: This compilation is a work in progress. For comments, questions, or additions, please contact Denise Mulholland of the U.S. EPA State and Local Climate Change Program at 202-260-4005 or mulholland.denise@epa.gov.

¹ Source: *Iowa Greenhouse Gas Action Plan*, Iowa Department of Natural Resources, 1996.

² Source: Ibid.

³ Sources: *National Conference of State Legislatures Energy Newsletter*, Vol.4, Number 3, Winter 1997; *The Green Power Network*, U.S. Department of Energy EREN, www.eren.doe.gov/greenpower, October 5, 1998; *State Renewable Energy News*, Volume 6, No.1, Winter 1997, NARUC Subcommittee on Renewable Energy; *Green Power Newsletter*, Number 6, March 1998, The Regulatory Assistance Project, www.rapmaine.org; Colorado Wind Power Buyers, Land and Water Fund of the Rockies, September 1998; Colorado Solar Energy Industries Association, www.coseia.org/rebate.html, August 1998; *Renewable Energy Sourcebook: A Primer For Action*, Public Citizen, www.citizen.org/CMEP/renewables, June 1998;

Green Power Notes, Center for Energy Efficiency and Renewable Technologies (CEERT), Center for resources Solutions (CRT), and Renewable Energy Marketing Board (REMB), www.cleanpower.org and www.green-e.org, June 1998;

The States and Global Climate Change: Adopted and Proposed Initiatives, Submitted by The Center for Policy Alternatives, prepared by The Harrison Institute for Public Law, 1997;

State and Local Legislative and/or Administrative Actions Having Direct or Incidental Effects on Greenhouse Gas Emissions, Center for Global Change, April 1992;

Database of State Incentives for Renewable Energy, North Carolina Solar Center and Interstate Renewable Energy Council (IREC), www.solar.mck.ncsu.edu, May 1998;

Government Actions on Climate Change in the Metropolitan NY/NJ/CT Region, Regional Plan Association, March 1998;

⁴ *The Source for Renewable Energy*, <http://www.sourceguides.com/energy/businesses>, October 1998.



\$458 million will be saved by Illinois companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



ILLINOIS

More ENERGY STAR Facts

- Illinois is home to 253 companies and public entities participating in ENERGY STAR partnerships.
- Over 420 million square feet of Illinois building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area over 460 times the size of the United Center Stadium.
- 12 ENERGY STAR-Labeled Product manufacturers are located in Illinois.
- Investments already made through the ENERGY STAR program in Illinois will prevent over 14 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 1.9 million acres of trees — an area 1290 times the size of the University of Illinois-Urbana Champaign.
- Nitrogen oxide (NO_x) emissions will be reduced by 37 million pounds and sulfur dioxide (SO₂) by over 100 million pounds due to ENERGY STAR programs in Illinois.

Highlights

- Northern Illinois Medical Center received the Green Lights Healthcare Partner of the Year Award in 1999.
- McDonald's Corporation (Oak Brook) received the Green Lights Retail Partner of the Year Award in 1998.
- Cooper Lighting received the Green Lights Manufacturing Ally of the Year Award in 1994.
- One of Illinois' landmark buildings, the Sears Tower, has expressed its commitment to being among the top 25 percent in energy performance nationally.

Market Potential

- Illinois has over 3.4 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$1.2 billion would be saved annually
 - The following emissions would be prevented each year:
 - 27 billion pounds of CO₂
 - 103 million pounds of NO_x
 - 305 million pounds of SO₂

ENERGY STAR Participants in Illinois

1999 Avenue of the Stars
 ABC Industries
 ADA Systems
 AKA Caterers
 ALA Cante Ennment
 ALP Lighting and Ceiling Products
 Abbots Laboratories
 Advance Electrical Supply
 Advance Transformer Co.
 Aero-Tech Light Bulb Company
 Alkco
 All Tech Lighting
 American Energy
 American Environmental Analytical Corp.
 American Fluorescent Corp.
 American Power Company
 American Society of Healthcare Engineers for AHA
 Ameritech Corporation
 Amoco
 Andrew Corporation, Communication Products
 Andrew Corporation, Communication Systems
 Andrew Corporation, Wireless Products
 Appliance Control Technology
 Architects, Designers, & Planners for Social Resp
 Arrowhead Environmental Control, Inc.
 Assn of Professional Energy Consultants (APEC)
 Augustana Lutheran Church
 Automotive Wholesalers of Illinois
 BT Office Products International, Inc.
 Baxter Healthcare Corp
 Big Beam Emergency Systems
 Bio-Systems Corp
 Blackstone Health Food Coop
 Bright Electrical Supply Co.
 Buddy Guys Legend
 Building Officials and Code Administrators
 C & H Joint Venture/Enterprises
 CF Industries, Inc.
 Cliff's Market
 Cap and Seal Company
 Caterpillar, Inc., Headquarters
 Caterpillar, Inc., TTID
 Central Illinois Light Company (CILCO)
 Central Illinois Public Service Company
 Chicago Botanic Garden
 Chicago Economic Development Commission
 Chicago-Edison Corporation
 Chicago Public Schools
 The City of Chicago, Illinois
 Chicagoland Chamber of Commerce
 Chicagos Beef-n-Dogs
 Clyde L. Choate Mental Health Center
 College of DuPage
 Com Systems Marketing
 Community Consolidated School District #62
 Conservation Technology, Ltd.
 Consumer Cooperative Credit Union
 Continental Bank Corporation
 Cook County, Illinois
 Cooper Lighting
 Cooper Lighting Group
 Crossroads Subway 12007, Merrillville, IL
 Culver Aurora IL
 Dauble P Corp
 Davis Controls Corporation
 Diamond F Lighting
 Dir of Env & Safety Services
 Double P. Corp
 Duray Fluorescent Manufacturing
 Dynamic Energy Products
 EESCO
 EJ Brach Corporation
 El Paso IGA Foodliner
 EPA Region 5
 EPRI/IFMA CKV Laboratory
 ESCO International
 East Maine School District #63
 Eastern Illinois University
 Ecological Products
 Equity Property Trust
 Expansions
 Fairmont Minerals, Ltd.
 First Chicago NBD
 Flat Top Grill
 G.D. Searle Company
 Grandview IGA Foodliner
 Gabco Enterprises, Inc.
 Genesis Lighting Management Services, Inc.
 Glen Ellyn Brewing Co.
 The Village of Glenview Board, Illinois
 The Glenview Library Board, Illinois
 The Glenview Park District Board, Illinois
 Glenview (IL) School District #225
 Good Earth Lighting, Inc.
 Gray Supply Company
 Grove Plating
 Guardian Corporation
 H Group Holding
 H & H Industries
 Hometown IGA
 Hampton Electronics, Inc.
 Harco Lighting Supply
 Harris Bankcorp Incorporated
 Helene Curtis
 Hit The Road Jack, Inc.
 Holcor
 Holiday Inn
 Hospitality Works, Inc
 Hucker Electric Company
 Hyatt Corporation
 Hydro-Flo Technologies
 IGA Foodliner
 Illinois Agricultural Association
 Illinois State University
 Imperial Lighting Maintenance Co
 Information Associates
 Inland Environmental
 Inn on Edwards
 Innovative Probing Solutions
 Institute of Real Estate Management
 Intec Systems
 Integrated Building Solutions, Inc.
 Internet Mortgage
 Iris B. Communications
 Italian Village
 Jay's IGA
 J.C. Proctor Endowment Home
 JFMC Facilities Corporation
 Jewel Food Stores
 John Buck Company
 Jolley Goods Entr
 Jolt Lighting Incorporated
 Juno Lighting, Inc.
 Kent's IGA Foodliner
 Katies Café & Carryout
 Kenall Lighting
 Kirby Foods
 Kurtzon Lighting
 LE Griffith & Associates
 LG Electronics U.S.A., Inc.
 Lincoln IGA
 Latin American Chamber of Commerce
 Lighting Maintenance, Inc. (IL)
 Lighting & Lowering System
 Litronics International
 MCI Telecommunications Corp/Bensenville
 MCI Telecommunications Corp/Willow Springs
 Magnaflux, Division Of ITW
 Managerial Services Inc.
 Maple Chase Company
 Marmom Group
 Marsh Company
 McDonald's Corporation
 McHenry County Housing Authority
 Metropolitan Chicago Healthcare Council
 Metropolitan Water Rec Dist/Gr Chicago
 MicroLite Corp., Subsidiary of Pittway
 Midwest Auger-Aerator
 Monnex Technologies
 Montgomery Ward & Company, Incorporated
 Motorola Incorporated
 Motorola Lighting, Inc.
 NEC Technologies
 NECA, Illinois Chapter
 The City of Naperville, Illinois
 Northbrook (IL) School District #30
 Northeastern Illinois University
 Northern Illinois Medical Center
 Northern Illinois University
 Northgate Electric
 Northwest Community Healthcare
 Norwood Park Evangelical Lutheran Church
 Hartland Lighting Service
 Olympia Community Unit School District 16
 Paxton IGA Foodliner
 Palmer Bellevue Corporation
 Peyton Elevator Co
 Planned Lighting, Inc.
 Power Saver
 Pre Finish Metals
 Printing Industry of IL/IN
 Pro Office Services
 Quantum Lighting Services
 R.R. Donnelley and Sons Company
 Rushville IGA
 Randolph & Associates
 Ravenswood Hospital Medical Center
 Refrigeration Services Engineers Society
 Robertson Transformer Company
 S Mechanical Technologies, Inc.
 Salem IGA Foodliner
 Sam's IGA
 S.C.F., Inc.
 Shaw's IGA Food Pride
 City of St. Charles Electric Utility
 St. Elizabeths Hospital (IL)
 St. Mary's Hospital (IL)
 Sam & Pams Bar & Grill
 Scholastic Enterprises
 The Schultz Company
 SeaquistPerfect Dispensing - A Division of AptarGroup
 Shelter
 Siebe Environmental Controls, Illinois
 Sieben Energy Associates
 Siemens Building Technologies, Landis Division
 Silverlight Corporation
 Skanda Lights
 Skeff Distributing Company, Inc.
 Smart Office Service, Inc.
 Solberg Manufacturing, Inc.
 Southern Illinois University at Edwardsville
 Spartan Printing Company
 Spent Lamp Recycling Technologies
 Square D Company
 Starmill Inc.
 State Farm Mutual Automobile Ins Co
 Steel Tank Institute
 Steiner Electric Company
 Sterling Industries
 Sterling, RMC
 Sting Pub & Eatery, The
 Subway Sandwiches and Salads
 Superior Lighting Company
 Swedish Covenant Hospital
 TECO Information Systems, Inc.
 Tracy's Food Center
 The Butler Did It
 Illinois Army National Guard
 Veterans Affairs Medical Center/West Side Chicago
 Underwriters Laboratories, Inc.
 Uniqema
 Universes Network
 University of Chicago
 The University of Illinois at Chicago
 Up & Running Café
 Van's South Grand IGA
 Vilijanna Coffee Ltd
 Viskase Corporation
 Visual Images, Incorporated
 WMX Technologies Incorporated
 WW Grainger Incorporated
 Waldmann Lighting Company
 Walgreen Co.
 Waste Reduction Action Coalition
 Waterlink/Great Lake Environmental
 Wheaton Park District
 Woodstock Lamp & Shade Company
 YMCA at the University of Illinois, Urbana-Champaign
 Zehr Foods Inc
 DBA Mackinaw IGA
 Zenith Electronics Corporation
 Zest Of The West

Examples of Illinois Partners Saving Money and Helping the Environment

McDonald's, Oak Brook

"McDonald's has always been interested in the leading energy conservation technology, and we would have upgraded our lighting eventually. But I certainly believe that being a Green Lights Partner helped us get it done much quicker."

— Joe Megacz, Project Engineer

- Saving \$1.9 million in annual energy costs
- Upgraded lighting in more than 5,000 restaurants
- Reducing energy use by 27 million kWh annually, a 40% reduction
- Preventing 50 million pounds of CO₂ annually

Augustana Lutheran Church, Chicago

"If 2,000 congregations made similar renovations ... it would save \$2.4 million that could be used for the church mission."

— Joe Ebenezer, Project Director

- Saving \$1,200 in annual energy costs
- Metropolitan Chicago Synod created a revolving fund so other churches could upgrade lighting as well
- Preventing 25,000 pounds of CO₂ annually



Abbott Laboratories, North Chicago

- Saving \$2 million in annual energy costs
- Reducing lighting costs by 43 percent
- Upgraded 14 million sq. ft.
- Reducing energy use by 40 million kWh annually
- Preventing 68 million pounds of CO₂ annually

Amoco, Chicago

- Saving over \$1 million annually on lighting retrofits alone
- Reducing energy use by 18.6 million kWh annually
- Preventing 33 million pounds of CO₂ annually

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Illinois

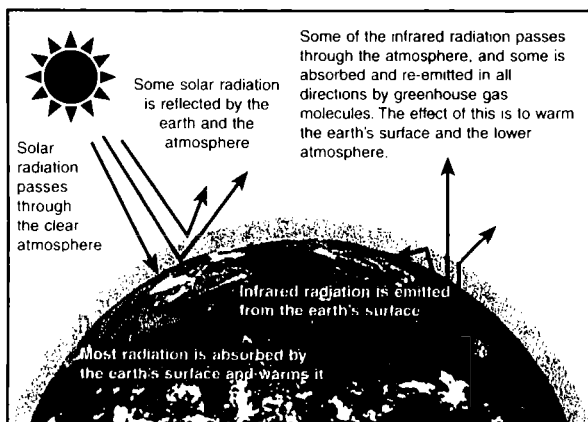
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, common air pollutants, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally.

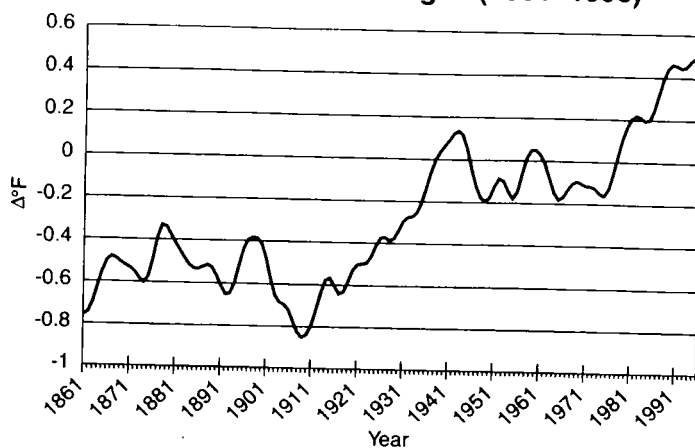
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in Decatur, Illinois, has decreased 0.2°F, and precipitation has increased by up to 20% in many parts of the state.

Over the next century, climate in Illinois could experience additional changes. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Illinois could increase by about 2°F in summer (with a range of 1-4°F), 3°F in winter and spring (with a range of 1-7°F), and 4°F in fall (with a range of 2-9°F). Precipitation is estimated to increase by about 10% in winter and spring, 15-50% in fall, and 25-70% in summer. Other climate models show different results, with winter precipitation increasing more than summer precipitation. The amount of precipitation on extreme wet days is likely to increase, especially in summer. The frequency of extreme hot days in summer would increase because of the general warming trend. Although it is not clear how severe storms would change, an increase in the frequency and intensity of summer thunderstorms is possible.

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

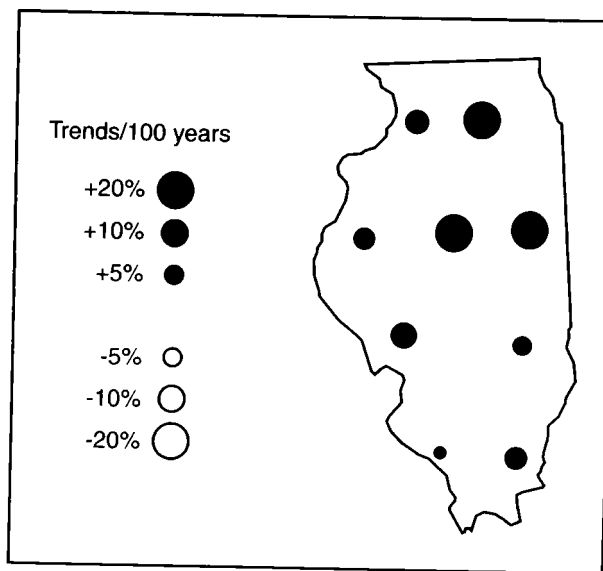
For a given concentration of greenhouse gases, the resulting increase in the atmosphere's heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Illinois, with its irregular, intense heat waves, could be especially susceptible.

In Chicago, one study projects that by 2050 heat-related deaths during a typical summer could increase 85%, from about 190 heat-related deaths per summer to nearly 360 (although increased air conditioning use may not have been fully accounted for). Winter-related deaths are expected to change very little. The elderly, particularly those living alone, are at greatest risk.

Climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbon emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

A 4°F warming in the Midwest, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by as much as 8%. Currently, the Chicago area is classified as a "severe" nonattainment area for ozone. Ground-level ozone has been shown to aggravate respiratory illnesses such as asthma, reduce existing lung function, and induce respiratory inflammation. In addition, ambient ozone reduces crop yields and impairs ecosystem health.

Warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitoes flourish in Illinois, and some carry St. Louis encephalitis. Also, the mosquitoes that carry dengue fever, Eastern equine encephalitis, and LaCrosse encephalitis recently have spread as far north as Chicago. Global warming could shift northward the region where these mosquitoes breed and overwinter. If conditions become warmer and wetter, mosquito populations could increase, thereby increasing the risk of transmission of these diseases.

Water Resources

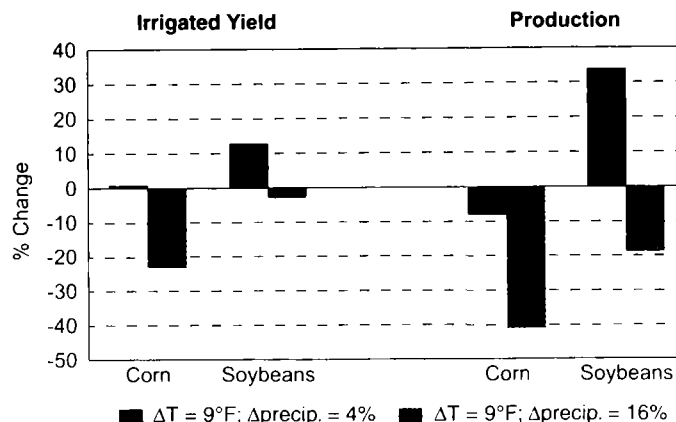
Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. If streamflow and lake levels drop, groundwater also could be reduced. In addition, more intense precipitation could increase flooding.

Most of Illinois drains into the Mississippi River, which forms the state's western boundary. Tributaries include the Illinois River, the Rock River, and several smaller rivers. A small portion of the eastern part of the state drains into the Wabash River. Fall and spring rains largely determine runoff in the major tributaries and, to a lesser degree, spring snowmelt. Warmer temperatures would result in less snow, earlier snowmelt, and increased summer evaporation. Hence, winter runoff could increase, and summer and fall runoff could decrease. Changes in summer and fall runoff depend on changes in rainfall, which could either increase or decrease. With a drier climate, irrigation needs for agriculture could increase, whereas wetter conditions could exacerbate local flooding. Increased evaporation along with less rainfall could reduce recharge of groundwater aquifers, while increased rainfall could contribute to recharge.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other sectors.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

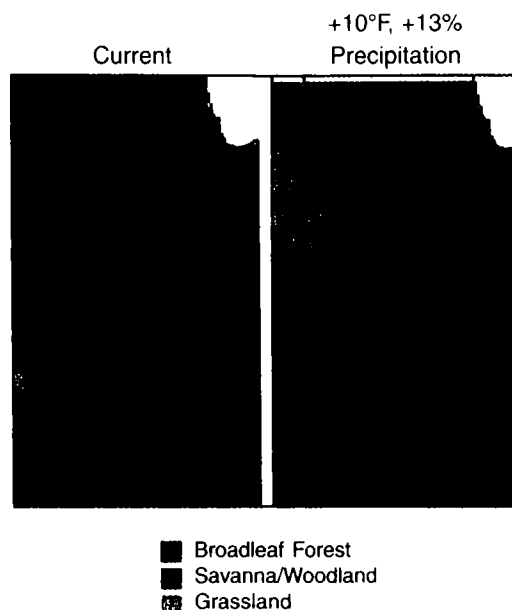
In Illinois, agriculture is an \$8 billion annual industry, three-fourths of which comes from crops. Very little of the crop acreage is irrigated. The major crops in the state are corn and soybeans. Irrigated and dryland yields of corn could change little or be reduced by as much as 32%, while soybean yields could vary from a drop of 24% to an increase of 13%. This could lead to changes in acres farmed and production. For example, corn yields could rise while production falls because of a decrease in corn acres farmed.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic range, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to warmer conditions, such as oaks and southern pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Illinois may change little or could increase by as much as 10-40%, depending on competition from agricultural uses. In addition to competition, the uncertainties depend on many other factors, including whether soils become drier and, if so, how much drier. With hotter, drier weather, southern pines gradually could replace deciduous forests in the southern part of the state, particularly in areas with rich soils. In areas with poorer soils, which are more common in Illinois forests, scrub oaks of little commercial value (e.g., post oak and blackjack oak) could increase. In contrast, warmer, wetter conditions could expand northward the range of deciduous forests.

Changes In Forest Cover



Source: VEMAP Participants (1995); Neilson (1995)

Ecosystems

The forests and woodlands of Illinois support a variety of animals, including 80% of the mammals, 60% of the birds, and 80% of the amphibians and reptiles that inhabit the state. Climate change could cause substantial shifts in the ranges that support these species, perhaps leading to some migration of species, which would be difficult because of fragmented land use patterns. Warmer winter temperatures could increase insect populations and plant disease that could affect adversely forest ecosystems.

Prairies support 117 of the nearly 500 plant and animal species considered endangered or threatened in Illinois. Because of the extensive fragmentation of Illinois' prairies, it could be difficult for some species to migrate in response to climate change. Wetlands such as the riparian habitats along the Mississippi, Ohio, and other rivers and streams could be especially sensitive to climate change. Changes in precipitation could affect flooding patterns and availability of nutrients. Aquatic species that are sensitive to water temperature could be affected adversely by climate change. Habitat for fish such as smallmouth bass, walleye, and northern pike could be reduced.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.





Climate Change Mitigation in Illinois

Illinois' Greenhouse Gas Emissions (1990)¹

- Total greenhouse gas emissions in 1990 were about 62 million metric tons of carbon-equivalent, about 5% of the U.S. total (U.S. Climate Action Plan, U.S. Department of State, 1997).
- Per capita emissions in 1990 were about 6 metric tons per person, slightly higher than the national average of 5.
- The major source of energy-related greenhouse gas emissions in Illinois was transportation, which accounted for about 30% of emissions. The second highest source was electric utilities, which accounted for 28% of the total, followed by industrial activities, responsible for 22% of the emissions.

Mitigation Policy Planning:

- In June 1994, the Illinois Task Force on Global Climate Change, through the Illinois Department of Energy and Natural Resources, published *A Climate Change Action Plan for Illinois*. The box below lists the policies recommended the report².

Policies recommended in Illinois:

Residential:

Energy efficiency improvements via conservation measures (for A/C, Hot water heaters, Refrigerators, residential furnaces, new housing measures)

Commercial:

Conservation measures relating to A/C (in schools, recreation facilities, prisons), refrigeration (multiple compressors, glass doors for supermarket displays), lighting (Fluorescent lamps, ballasts, lighting fixtures, lighting control switches)

Industrial:

Lighting and motor improvements: Fluorescent lamps, ballasts, lighting fixtures, lighting control switches
CO2 scrubbers

Transportation:

CAFE standards (30 mpg)
Gasohol, Ethanol vehicles (*promote research and development*)
CNG vehicles (*promote research and development*)

Electricity generation:

Utility transformers
Natural gas switching

Forestry/Land Use:

Expand rural and urban tree planting programs
Increase forest management assistance to private forest owners
Provide cost-sharing and technical assistance for tree planting and management

Cross-sector:

Joint Implementation

Existing Illinois Policies that reduce greenhouse gas emissions³:

Sample of Existing Policies or Programs:

- Property tax incentives for renewable energy systems
- Alternative Energy Bond Fund Program
- Systems Benefits Charges - Renewable Energy Resources Trust Fund
- Electricity Disclosure
- Tree planting initiatives
- Incentives to promote ethanol

Benefits of Reduced Reliance on Fossil Fuels: Increased opportunities for Illinois

Increases in renewable energy use and energy efficiency improvements would provide new economic opportunities for many industries. Some states already reap significant benefits from reduced reliance on fossil fuels. For example, 33% of all U.S. solar collector shipments, valued nationally at \$29.8 million in 1996 (EIA Renewable Energy Outlook 1997), originated in California. Similar industries in Illinois could experience gains from a shift away from fossil fuels.⁴

Solar- and PV-related products and services in Illinois:

- *Companies include:* Alternative Energy Products in Mc Henry, Alternative Energy Systems in Tonica, Atlantic Solar Products Inc. in Naperville, Care Free Energy Sales in Rockford, Clarion Products Group Inc. in Evanston, Coml Energy Concepts Inc. in Mc Henry, Double Diamond Energy in Mount Sterling, Elec Energy Inc. in Joppa, The Energy Bank in Jacksonville, Energy Conserv Specialists in Highland Park, Energy Culvert Co Inc. in Energy, Energy Efficiency Consultants in Charleston, Energy Exploration Inc. in Vienna, Energy Management Systems Of Illinois Inc. in Staunton, Energy Mart in Harrisburg, Energy Reproduction Systems in Herrin, Energy Savers in Highland Park, Energy Savers Co. in Salem,
- Energy Service Inc. in Mount Carmel, The Energy Shop in Prophetstown, Energy Specialists in Minonk, Energy Specialty Prod Inc. in Oak Park, Energy Store in Lemont, Energy Well Service Inc. in Olney, Energy Wise Inc. in Rockford, Eternal Energy in Kewanee; G & G Energy Shed in Seaton, Genl Energy Corp in Oak Park, Global Alternative Energy Solutions in Chicago, Greater Rockford Energy in Rockford, Heinz Roofing in Peoria, Hollister Energy Systems in Rockford, Howard Energy Corp in Mount Carmel, Illinois Home Energy Assist in Rockford, Key Energy Resources Inc in Rockford, Kunzeman Solar Power Systems in Decatur, Maverick Energy Incorporate in Robinson,
- McIntosh Energy Systems in Iuka, Midway Labs Inc. in Chicago, Nippon Electric Glass America, Inc. in Tasca, Salem Energy Supply & Service in Salem, PCM Thermal Solutions in Naperville, Phelps Energy Servs in Spring Valley, Phoenix Builders Ltd in Rolling Meadows, R B Energy Assoc in Rockford, Rockford Energy Alternative in Rockford, Siebe Appliance Controls in Carol Stream, Bruce T. Smith in Peoria, Solar & Cermic in Chicago, Solar Energy Control Enterprise in New Lenox,
- Solar Film Energy Control in New Lenox, Solar Heating & Air Conditioning in Peoria, Solar Service in Lincolnwood, Solar Solutions in Oregon, Sunnyside Energy Syst in Atlanta, SunPipe Company, Inc. in Northbrook, Suntech Energy Corp in Rockford, Sunwise Energy in Orland Park, SunWize Energy Systems, Inc. in Mokena, U S Energy Corp in Marion, World Quality Solar Service Inc. in Chicago.

Energy Efficiency-related Products and Services in Illinois:

- *Companies include:* Davis Caves in Armington and Optimum Lighting Solutions in Schaumburg.

Electric Vehicles (autos and lawnmowers):

- *Companies include:* Electric Vehicle Corp. in Champaign and Sears, Roebuck & Co. in Hoffman Estates.

Win-Win Climate Mitigation Projects in Illinois⁵

City of Chicago and the EPA State and Local Climate Change Program

- As a partner in the Cities for Climate Protection Campaign, the city of Chicago has committed to conducting an emissions inventory, to adopting an emissions reduction target, and to implementing a strategy to achieve the target.

City of Chicago and Climate Wise

- As a new Climate Wise Local Government Ally, the City of Chicago is developing an outreach strategy that will seek to disseminate energy efficiency information through a series of business workshops. They are also looking to combine the buying power of several smaller companies in order to obtain lower cost Environmental Service Corporation Contracts.

Abbott Laboratories and WasteWiSe

- Abbott Laboratories held a Corporate Office Cleanout Day and recycled 90,000 pounds of office paper. They also redesigned its secondary packaging and conserved 500,000 pounds of corrugated paper in 1996.

Helene Curtis Industries and WasteWiSe

- Helene Curtis Industries sold over 148,000 pounds worth of 30-55 gallon PET drums that hold their raw materials to another company for reuse.

McDonald's and WasteWiSe

- McDonald's prevented more than 16 million pounds of total waste. For example, McDonald's conserved more than 12 million pounds of mixed paper by reducing the size of its napkins by 1 inch. In addition, by decreasing the weight of carryout bags, McDonald's conserved 3,686,562 pounds of kraft/brown paper.

Motorola and WasteWiSe

- Motorola collected cleanroom booties and gloves for reprocessing and reuse, conserving 139,600 pounds of mixed plastic clothing.

Navistar and WasteWiSe

- Navistar International saved 938,000 pounds of corrugated from being landfilled by reusing packaging.

Baxter International and WasteWiSe

- Baxter International reduced its packaging waste by over 11,600,000 pounds since 1994.

NOTE: This compilation is a work in progress. For comments, corrections, questions, or additions, please contact Denise Mulholland of the U.S. EPA State and Local Climate Change Program at 202-260-4005 or mulholland.denise@epa.gov.

¹ Source: *Illinois Inventory of Greenhouse Gases and Sinks: 1990*, Illinois Department of Energy and Natural Resources, 1995.

² Source: *A Climate Change Action Plan for Illinois, Report of the Task Force on Global Climate Change*, Illinois Department of Energy and Natural Resources, June 1994.

³ Sources: *National Conference of State Legislatures Energy Newsletter*, Vol.4, Number 3, Winter 1997; *The Green Power Network*, U.S. Department of Energy EREN, www.eren.doe.gov/greenpower, October 5, 1998; *State Renewable Energy News*, Volume 6, No.1, Winter 1997; NARUC Subcommittee on Renewable Energy; *Green Power Newsletter*, Number 6, March 1998; The Regulatory Assistance Project, www.rapmaine.org; Colorado Wind Power Buyers, Land and Water Fund of the Rockies, September 1998; Colorado Solar Energy Industries Association, www.coseia.org/rebate.html, August 1998; *Renewable Energy Sourcebook: A Primer For Action*, Public Citizen, www.citizen.org/CMEP/renewables, June 1998;

Green Power Notes, Center for Energy Efficiency and Renewable Technologies (CEERT), Center for resources Solutions (CRT), and Renewable Energy Marketing Board (REMB), www.cleanpower.org and www.green-e.org, June 1998;

The States and Global Climate Change: Adopted and Proposed Initiatives, Submitted by The Center for Policy Alternatives, prepared by The Harrison Institute for Public Law, 1997;

State and Local Legislative and/or Administrative Actions Having Direct or Incidental Effects on Greenhouse Gas Emissions, Center for Global Change, April 1992;

Database of State Incentives for Renewable Energy, North Carolina Solar Center and Interstate Renewable Energy Council (IREC), www-solar.mck.ncsu.edu, May 1998;

Government Actions on Climate Change in the Metropolitan NY/NJ/CT Region, Regional Plan Association, March 1998;

⁴ *The Source for Renewable Energy*, <http://www.sourceguides.com/energy/businesses>, October 1998.

⁵ *U.S. Communities Acting to Protect the Climate: A report on the Achievements of ICLEI's Cities for Climate Protection - U.S.*, International Council for Local Environmental Initiatives, November 1997; EPA Program Managers as of November 1997. For further information, please see www.epa.gov/globalwarming.



\$231 million will be saved by Wisconsin companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.

WISCONSIN



1848

WISCONSIN

More ENERGY STAR Facts

- Wisconsin is home to 91 companies and public entities participating in ENERGY STAR partnerships.
- 155 million square feet of Wisconsin building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 130 times the size of Miller Park.
- 5 ENERGY STAR-Labeled Product manufacturers are located in Wisconsin.
- Investments already made through the ENERGY STAR program in Wisconsin will prevent over 8 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 1 million acres of trees — an area 1070 times the size of the University of Wisconsin-Madison.
- Nitrogen oxide (NO_x) emissions will be reduced by over 23 million pounds and sulfur dioxide (SO₂) by 59 million pounds due to existing ENERGY STAR investments in Wisconsin.

Highlights

- Johnson Controls received the ENERGY STAR Buildings Ally of the Year Award in 1999 and the ENERGY STAR Green Lights Ally of the Year Award in 1993.
- The Trane Company (LaCrosse) received the ENERGY STAR Buildings Ally of the Year Award in 1998 and the ENERGY STAR HVAC Certificate of Distinction in 1996.

Market Potential

- Wisconsin has 1.5 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$340 million would be saved annually
 - The following emissions would be prevented each year:
 - 9 billion pounds of CO₂
 - 36 million pounds of NO_x
 - 102 million pounds of SO₂

ENERGY STAR Participants in Wisconsin

Athens IGA Super Market
 Adjustable Fixture Company
 All Lighting Inc.
 American Cat Emporium and Wood
 Products
 American Insulation Inc.
 August Winter & Sons Inc.
 Badger USA
 Brightside Pet Clinics
 Broan MFG Company
 Custom Fleet Maintenance
 Catalytic Combustion Corp
 Champion Insulation
 Earth Care Paper
 Energy Saver Products
 Environmental Stone Products
 Erickson's Diversified Corporation
 Extendicare Health Services
 Firstar Bank Madison NA
 Fliteway Technologies Inc
 GM Popkey Company, Inc.
 Global Energy Options, Inc.
 Green Bay Packers, Inc.
 Haderson Corporation
 Harley-Davidson, Inc.
 Hospital Council of Greater
 Milwaukee
 Illingworth Corporation
 Johnson Controls, Inc. - Controls
 Business
 Kohls Department Stores, Inc.
 Krueger International Incorporated
 Lallis Pizza
 Land's End, Inc.
 Lentz Engineering Associates, Inc.
 Lenz Lighting
 Lutheran Homes of Oshkosh
 Marcouillers IGA Foodliner
 MTI International
 MacWhyte Co., Division Amsted
 Industries
 Madison Gas And Electric
 Company
 Maysteel Corporation
 Memorial Hospital of Lafayette
 County

Milwaukee Area Technical College
 Milwaukee Chaplet & MFG
 Milwaukee Insurance
 Milwaukee Public Schools
 City of Milwaukee, Department of
 Public Works
 National Association of Independent
 Lighting Distributors
 Northern Lake Serv Inc
 Northland College
 Oasis Restaurant Inc.
 Orion Lighting
 PJS
 Point Sporting Goods
 Paragon Electric Company, Inc.
 Personalized Products
 Polk County, Wisconsin
 Quad Graphics
 Ramada Plaza of Fond Du Lac
 Rayovac Corporation
 Real Refrigeration
 Research Products Corporation
 Ruud Lighting
 SC Johnson and Son, Inc.
 SPI Lighting, Inc.
 St. Joseph's Hospital
 St. Michael Hospital (WI)
 School District of Elmbrook
 Schumaker Lighting Inc.
 Shear Entertainment
 ShopKo Stores, Inc.
 Snap-on Incorporated
 Standard Electric Supply
 Stay-Lite Lighting Service
 Subway #4974 Lake Geneva
 Terralux
 Timco Mfg Inc
 Trade Press Publishing Corporation
 Twin Lakes Area Chamber of
 Commerce
 US Lamp
 Wisconsin Army National Guard
 Visa Lighting Corporation
 Wausau School District
 Waverly Beach Sport Bar
 West Allis Memorial Hospital

Wisconsin Center for Demand-Side
 Research
 Wisconsin Electric Power Company
 Wisconsin Power & Light Co
 Wisconsin Public Power, Inc. System
 Wisconsin Public Service
 Corporation
 State of Wisconsin
 Wismarq Light Company, Inc.
 Zacho Sports Center

Examples of Wisconsin Partners Saving Money and Helping the Environment

ShopKo Stores, Green Bay

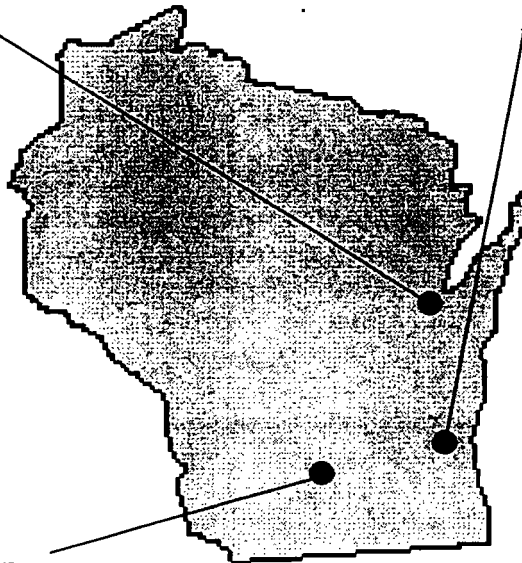
- Saving more than \$1 million in annual energy costs
- Upgraded lighting in over 10 million sq. ft.
- Preventing 36.3 million pounds of CO₂ annually

Milwaukee Public Schools, Milwaukee

"When we implemented the lighting retrofits throughout our schools, we received tremendous positive feedback from teachers and students about the quality of the lighting in the classrooms. We are now exploring ways to use the technical expertise of the Energy Star Buildings Partnership as we continue to upgrade our systems."

— Tom Chojnacki, Manager of Environmental Services

- Saving \$827,000 in annual energy costs
- Upgraded lighting in 18 million sq. ft., in 100 percent of its 158 facilities
- Reducing energy use by 13.2 million kWh annually
- Preventing 26 million pounds of CO₂ annually



State of Wisconsin, Madison

"Like most states, Wisconsin will be able to benefit from the long-term savings of installing energy efficient lighting because state facilities do not often change ownership. The upgrades have cut lighting loads by 50 percent without sacrificing light levels."

— Nathaniel Robinson, Administrator of the Department of Administration

- Saving \$7 million in annual energy costs
- Upgraded lighting in over 50 million sq. ft.
- Reducing energy use by 104 million kWh annually
- Preventing 209 million pounds of CO₂ annually

Harley Davidson, Milwaukee

- Saving \$40,000 in annual lighting costs
- Reducing energy use by 900,000 kWh annually
- Preventing 1.5 million pounds of CO₂ annually

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Wisconsin

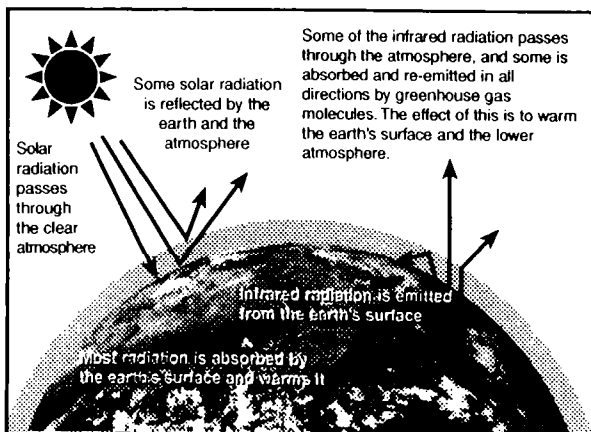
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

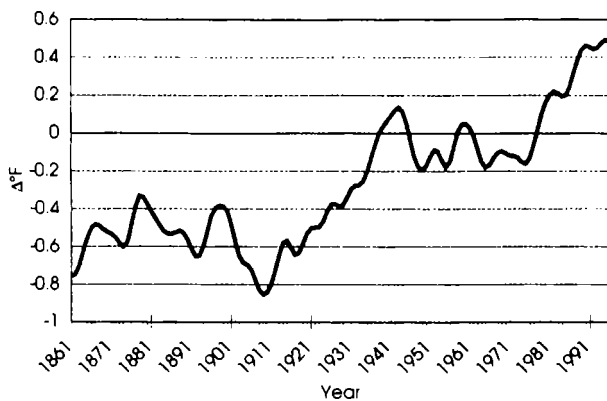
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F since the late 19th century. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that *“the balance of evidence suggests a discernible human influence on global climate.”*

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

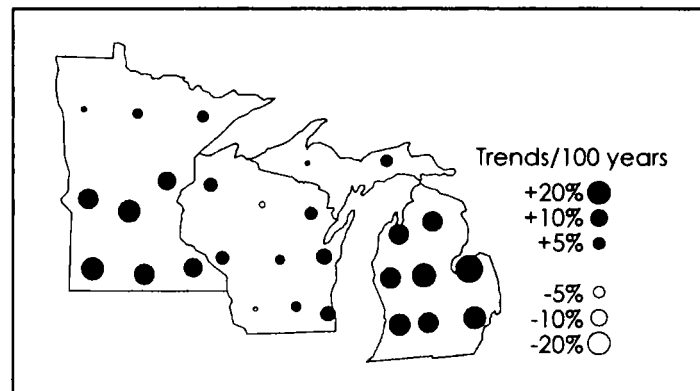
Local Climate Changes

Over the last century, the average temperature in Stanley, Wisconsin, has remained virtually unchanged, and precipitation has increased by 5-10% in some areas of the state.

Over the next century, Wisconsin’s climate may change significantly. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that has accounted for both greenhouse gases and aerosols, by 2100 temperatures in Wisconsin could increase by about 4°F (with a range of 2-7°F) in winter, spring, and fall, and by somewhat less in summer. Precipitation is projected to increase by 15-20% in winter, summer, and fall, with little change projected for spring.

The amount of precipitation on extreme wet days in summer most likely would increase. The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms would change.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves could increase the number of heat-related deaths and the incidence of heat-related illnesses. Wisconsin, with its irregular, intense heat waves, seems somewhat susceptible.

In Milwaukee, one study projects that a 3°F warming could almost double heat-related deaths during a typical summer from 30 per summer to about 55 (although increased air conditioning use may not have been fully accounted for). The elderly, particularly those living alone, are at greatest risk.

There is concern that climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbons emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

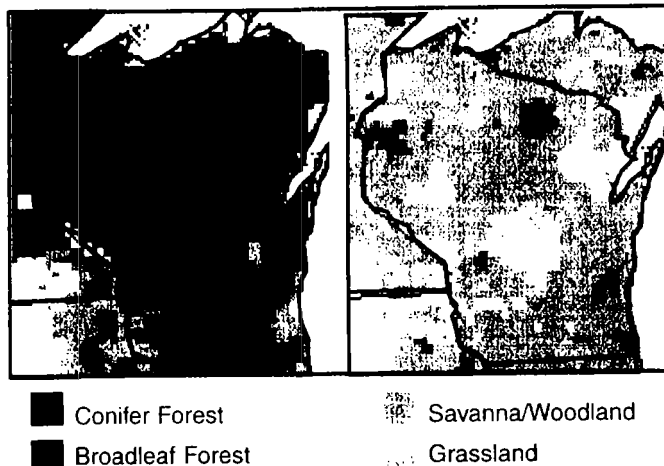
A 4°F warming in the Midwest, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by as much as 8%. Perhaps more important, however, is that the area exceeding national health standards for ozone could almost triple. Currently, Milwaukee-Racine, Door, Manitowoc, Marathon, and Oneida counties do not meet national standards for ozone. Ground-level ozone has been shown to aggravate existing respiratory illnesses such as asthma, reduce lung function, and induce respiratory inflammation. In addition, ambient ozone reduces crop yields and impairs ecosystem health.

Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitoes flourish in Wisconsin, and some carry St. Louis encephalitis. The mosquitoes that carry this disease could increase with climate change. Also, the mosquitoes that carry yellow fever, dengue fever, Eastern equine encephalitis, and La Crosse encephalitis recently have spread as far north as Chicago. Global warming could shift the region where these

Changes In Forest Cover

Current

+10°F, +13% Precipitation



Source: VEMAP Participants (1995); Neilson (1995)

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to these conditions, such as oaks and southern pines, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Wisconsin could change little or decline by 55-75%. The uncertainties depend on many factors, including whether soils become drier and, if so, by how much drier. Significant summer droughts with increased tree loss and wildfire frequency could be expected with hotter and drier weather. The mixed aspen, birch, beech, maple, and pine forests found in the north would shrink in range and would be replaced by a combination of grasslands and hardwood forests consisting of more oak, elm, ash, and pines. Grasslands and savanna eventually could replace much of the forest and woodland in the state. These changes would affect the character of Wisconsin forests and the activities that depend on them.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water

Resources in drier climates tend to be more sensitive to climate changes. Because evaporation from streams and lakes is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

About one-third of Wisconsin lies within the headwaters of the Mississippi River basin. The remainder contains numerous small rivers and streams, most of which drain to either Lake Michigan or Lake Superior. Earlier spring snowmelt under climate change could cause seasonal flows to peak sooner in most streams. Increased summer evaporation probably would reduce summer streamflows.

In the northern part of the state, as much as one-third of precipitation currently goes to groundwater. This amount almost certainly would decrease in a warmer climate because of increased evaporation, which would reduce many, if not most, of the state's aquifers. In addition, unless the difference were made up by increased precipitation, the reduction in groundwater could harm the health of Wisconsin's lakes.

The water temperatures of the Great Lakes could increase because of the warmer summer air temperatures and longer ice-free season, which could degrade water quality and increase evaporation. Perhaps more important, increased lake evaporation would decrease lake levels (typically a foot or more for a 4°F warming), which could increase shore erosion from wind and rain, but reduce flood damages.

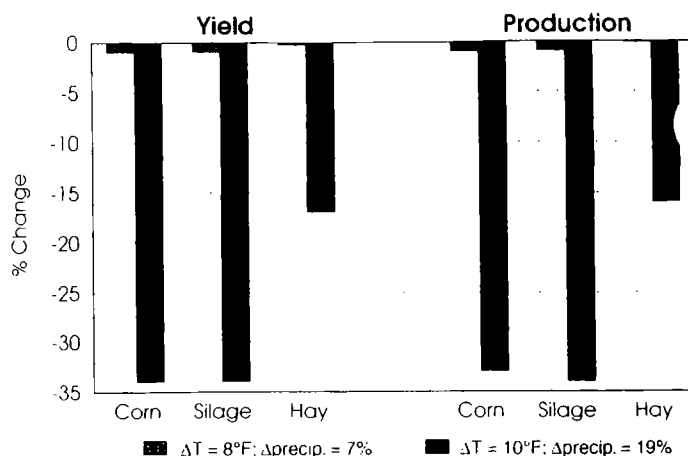
Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

In Wisconsin, agriculture is about a \$6 billion annual industry, of which three-quarters comes from livestock. The principal crops are corn, silage, and hay. About 3% of the state's farmed acres is

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

irrigated. Climate change could leave corn and silage yields unchanged, or they could decrease by up to 34%. Hay yields could remain unchanged or could decrease by 17%. Acreage use could remain largely unchanged, and farm income could remain unchanged or could increase up to 100%. Irrigated acreage could increase. This could further stress water supplies, and water quality could be further degraded.

Ecosystems

Wisconsin has diverse ecosystems that support a variety of wildlife. Wisconsin's aquatic wildlife includes brown trout, walleye, musky, largemouth bass, crayfish, snails, mussels, and freshwater sponges. These species rely on the state's vast water resources, which include more than 43,000 miles of flowing waters, more than 15,000 inland lakes, 800 miles of coastline, and wetlands covering approximately 5 million acres. Wisconsin is also home to a variety of birds and animals, including the bald eagle, osprey, Kirtland's warbler, deer, black bear, and gray wolf. One of the largest populations of Karner blue butterfly, an endangered species, is found in Wisconsin.

Climate change could influence many of Wisconsin's ecosystems. Brown trout could lose a majority of their habitat as a result of climate change. Prolonged drought from climate change could decrease the number of lakes with suitable habitat for organisms such as crayfish and snails. Drought also could decrease groundwater supplies of silica, an essential nutrient for freshwater sponges and diatoms. Climate change also could affect habitat for the well-known Kirtland's warbler. Because of the fragmentation of ecosystems from natural and human-caused barriers, many of Wisconsin's animals could have difficulty migrating in response to the effects of climate change.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.



Climate Change Mitigation in Wisconsin

Wisconsin's Greenhouse Gas Emissions (1990)¹

- Total greenhouse gas emissions in 1990 were about 35 million metric tons of carbon-equivalent, about 3% of the U.S. total for that year.
- Per capita emissions for 1990 were about 7 metric tons, higher than the 1990 national average of about 5.
- The major source of greenhouse gas emissions in Wisconsin was electric utilities, which accounted for about 33% of all emissions. The second highest source of greenhouse gas emissions in Wisconsin was transportation, which accounted for about 32% of all emissions in 1990.
- Emissions are projected to increase to 45 million metric tons, or 181 million short tons, of carbon dioxide, by 2010.

Mitigation Policy Planning:

- In April 1997, the Wisconsin Department of Natural Resources and the University of Wisconsin Consortium for Integrated Resource Planning completed the *Wisconsin Greenhouse Gas Emission Reduction Cost Study - Report 3 Emission Reduction Cost Analysis*.
- The study identified measures and technologies costing up to \$15 per ton which, if implemented, could reduce 36.8 million tons of emissions and return their emissions to 1990 levels by 2010 at a cost savings of \$466 million.
- Through additional funds from the U.S. Department of Energy Fitness Program, the Wisconsin Department of Natural Resources and the University of Wisconsin Consortium for Integrated Resource Planning went on to assess the economic benefits of making the energy efficiency investments identified. Their analysis concluded that "energy efficiency investments costing up to \$0 per ton of carbon dioxide reduced will create 7,255 new jobs, \$428 million in higher disposable income, and \$266 million in gross state product net of the electric sector in 2010."²

Existing Wisconsin Policies that reduce greenhouse gas emissions³:

Sample of Existing Policies or Programs:

- Net Billing Rules
- System Benefit Charges which include mechanism to allow support for investments in EE and RE and R&D
- Home Efficiency Loan Discounts
- Green Pricing Programs (Energy for Tomorrow, Solar Wise, Wind Power Green Pricing)
- Water Heater replacement (electric to gas) project
- Demand-side Management Programs
- Solar and Wind Access Laws
- Property tax incentives for solar and wind energy equipment
- Renewable Energy Assistance Program
- Education for refrigerant users about climate change and ozone-depletion.

Benefits of Reduced Reliance on Fossil Fuels: Increased opportunities for Wisconsin

Increases in renewable energy use and energy efficiency improvements would provide new economic opportunities for many industries. Some states already reap significant benefits from reduced reliance on fossil fuels. For example, 33% of all U.S. solar collector shipments, valued nationally at \$29.8 million in 1996 (EIA Renewable Energy Outlook 1997), originated in California. Similar industries in Wisconsin could experience gains from a shift away from fossil fuels.⁴

Energy efficiency related services and products in Wisconsin:

- Earth Preservation Funds, Inc. in Milwaukee, Earthwerks in Spring Green, Gimme Shelter in Amherst, Public Energy Systems in Green Bay, and RENEW Wisconsin in Madison.

Solar- and PV-related Products and services in Wisconsin:

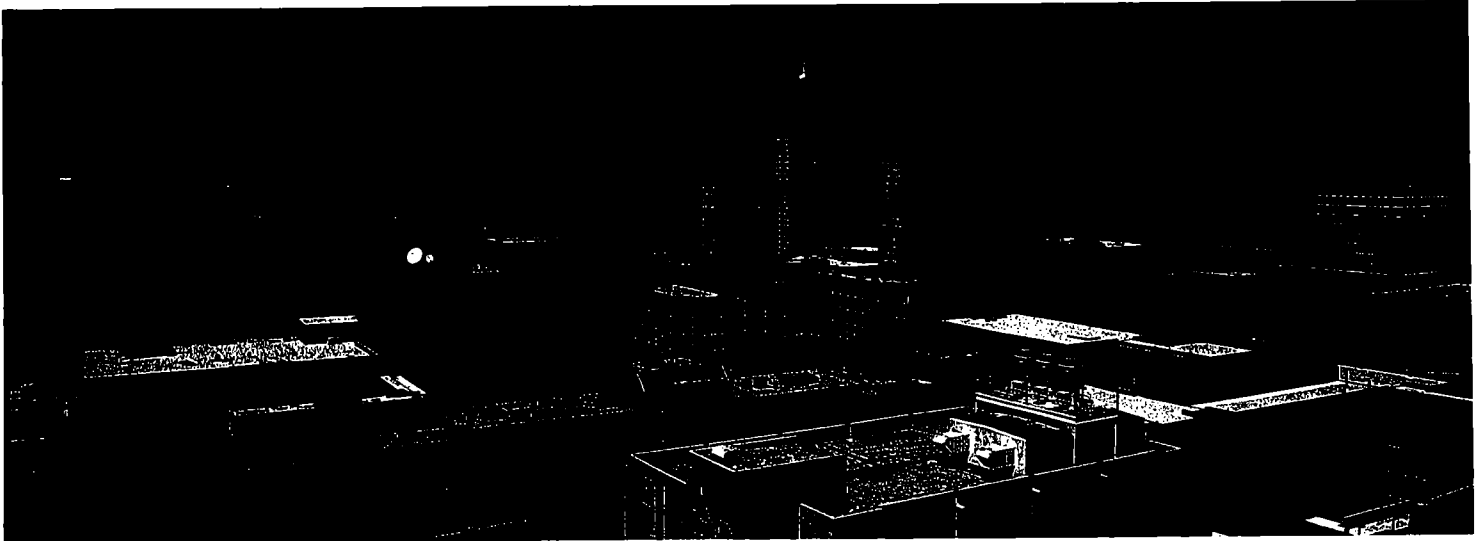
- Alternative Power Renewable Energy Center in Westby, Alternative Power Renewable Energy Center in

⁴ *The Source for Renewable Energy*, <http://www.sourceguides.com/energy/businesses>, October 1998.

⁵ *U.S. Communities Acting to Protect the Climate: A Report on the Achievements of ICLEI's Cities for Climate Protection - U.S.*, International Council for Local Environmental Initiatives, November 1997; EPA Program Managers as of November 1997. For further information, please see www.epa.gov/globalwarming.

JOHNSON
CONTROLS

Case Study



THE WISCONSIN ENERGY INITIATIVE

Saving Taxpayers' Money Through Facility Energy Efficiency

State of Wisconsin Energy Needs (Fiscal Year 1993)

The State of Wisconsin oversees the energy needs of six state agencies and more than 50 million square feet in over 6,600 buildings. Total monitored energy use equals 9,928 billion Btus.

Challenges

- Outdated systems and deferred maintenance wasted taxpayer dollars.
- Dozens of state buildings and state university campuses needed to improve energy efficiency and lower operating expenses without sacrificing occupant comfort.
- The standard bidding process cost the state valuable time and resources.

Solutions

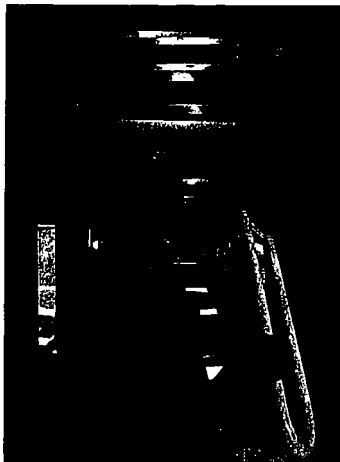
- Develop the Wisconsin Energy Initiative (WEI).
- Designate Johnson Controls, Inc. as coordinator of a new program uniting the State of Wisconsin and utilities in a unique effort to increase facility energy efficiency.
- Focus facility energy-efficiency activity on 1,000 of the largest buildings.
- Identify improvement opportunities that can be implemented quickly and pay for themselves in six years or less.

Results

- Energy savings to taxpayers of \$1.5 million plus in 1994 alone.
- Over 74,000 tons of power plant emissions eliminated from the atmosphere each year by 1996.
- Over 80 local companies hired for the project, creating jobs in Wisconsin.
- Energy-efficiency improvements implemented 18 months ahead of a normal standard-bid retrofit schedule. In many cases, the time from audit to implementation is less than four months.



Under the leadership of Wisconsin Governor Tommy Thompson, a new focus on energy efficiency results in tremendous savings of taxpayers' dollars, reduces power plant emissions and creates jobs.



WEI lighting retrofits conducted by Johnson Controls saved the University of Wisconsin-Milwaukee over \$100,000 in 1993.

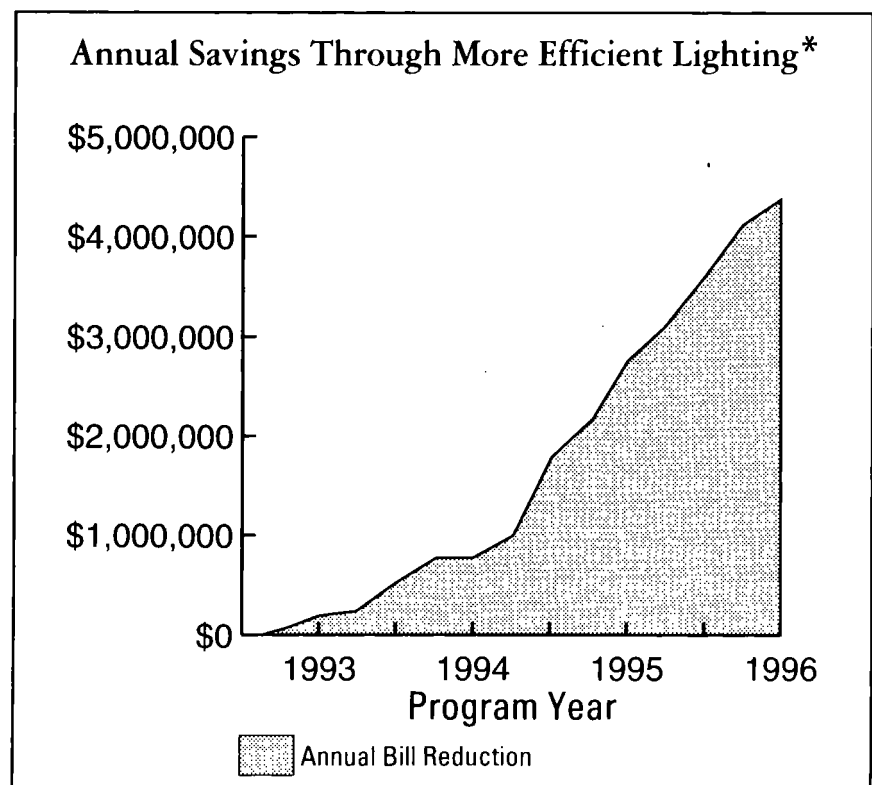
Wisconsin Leadership

Like many states, Wisconsin's energy programs multiplied during the 1970's energy crisis. But during the 1980s, stable energy prices reduced the focus on efficiency and conservation. As a result, state agencies' electricity consumption increased more than 27 percent.

Under the leadership of Governor Tommy Thompson during the 1990s, energy efficiency is a statewide priority. By developing the Wisconsin Energy Initiative (WEI), the state saves energy and taxpayer dollars, creates jobs and improves the environment.

WEI is an ambitious \$50 million, six-year energy conservation program involving government, business and utilities working together. Its goals include reducing the rate of electricity use by 20 percent by the year 2000, reducing the overall rate of energy use by 15 percent, recycling 100 percent of the ash generated from state heating plants, increasing co-generation at state heating plants by 50 percent and developing energy-efficiency standards for all future state construction.

This multi-faceted plan involves projects such as lighting system upgrades, replacing coal with alternative fuels, expanding recycling efforts and increasing electricity co-generation. The first facilities affected are the State Department of Administration and University of Wisconsin System campus buildings.



*All graphs based on data collected June 1994; figures beyond that date are estimated.

Through more efficient lighting, the State of Wisconsin has saved approximately \$1,040,000 through June 1994.

Immediate Action

WEI initially focuses on facility energy efficiency. Johnson Controls audit teams survey selected buildings. They review specific equipment operation and overall building efficiency, welcoming and including recommendations from state staff throughout the process. Improvements are recommended, and the state's Division of Facilities Development selects those that can best pay for themselves through savings. Money is then quickly made available and projects are implemented through innovative use of bulk purchasing and regional contracts. Funds also are available through agency budgets for additional work in conservation, building improvements and environmental protection.

The Difference is Results

The key difference between WEI and other state government programs is the simple and immediate transition from energy audits to completed building system modifications. The plan focuses on streamlining results.

These positive results are achieved quickly by hiring one consultant, Johnson Controls, to oversee the audit-into-action process which includes: conducting audits to identify energy saving opportunities; managing all sub-consultants, subcontractors and material suppliers; providing installation, materials and services for selected implementation projects; and securing utility rebates and study subsidies which help bring down project costs. The state realizes the savings in the next utility bill.

WEI is a leader in the nation, exceeding the expectations of the Environmental Protection Agency's "Green Lights" program. Green Lights is a voluntary partnership to promote cooperation between the public and private sectors in solving environmental problems through updated lighting technology.

"WEI has been a proactive solution to our state's growing conservation concerns. It has allowed our government, businesses and utilities to work together to achieve a cohesive, successful program that serves as a model for other states," says James R. Klauser, Special Counsel to the Governor, and Secretary, State of Wisconsin Department of Administration.

"The state has been able to cost-effectively implement projects in approximately one-tenth the normal time and in half the time mandated by the federal Green Lights program," says Robert Brandherm, Secretary, State of Wisconsin Building Commission.

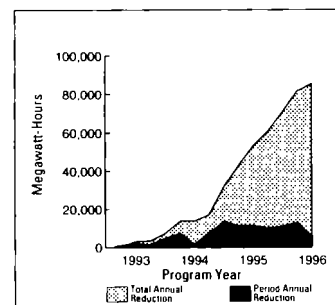
"The magnitude of the Wisconsin Energy Initiative has created a competitive atmosphere among material suppliers, contractors and material disposal/recycling companies, resulting in a decrease in implementation costs – which allows Wisconsin to implement additional energy conservation opportunities," he adds.



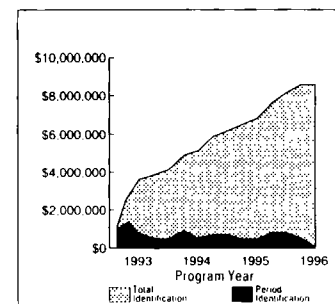
James R. Klauser feels WEI is a proactive solution to the state's growing conservation concerns.

"It [WEI] has allowed our government, businesses and utilities to work together to achieve a cohesive, successful program that serves as a model for other states."

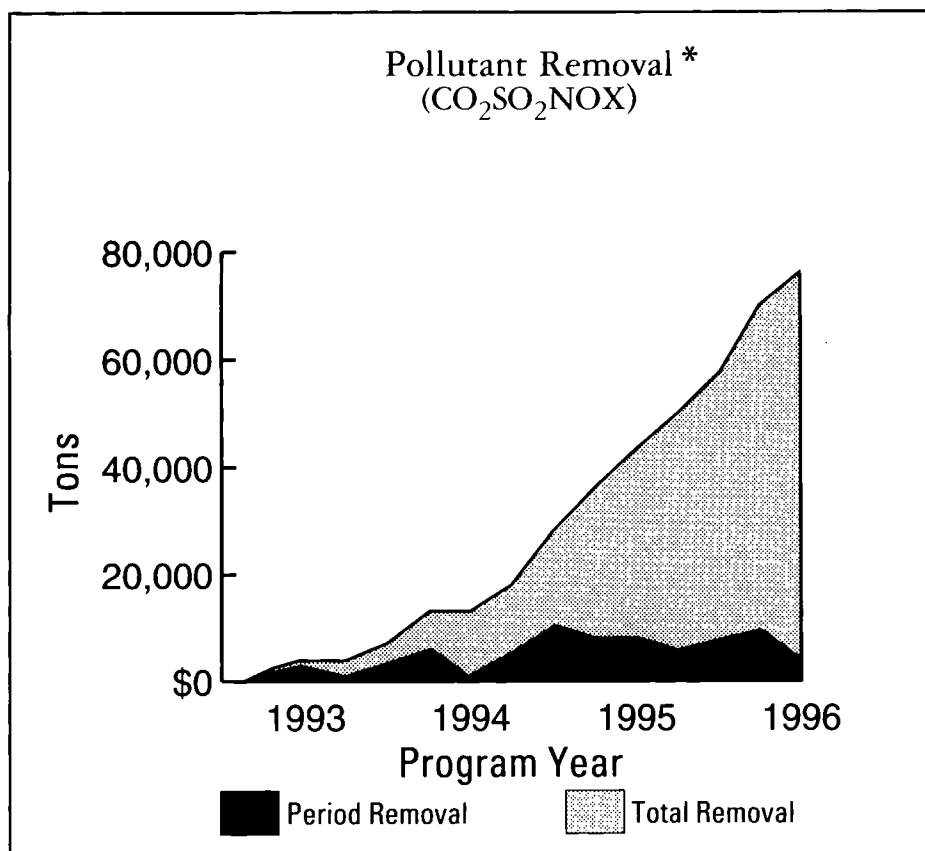
JAMES R. KLAUSER
Special Counsel
to the Governor and
Secretary, State of Wisconsin
Department of
Administration



Electric Consumption Reduction*



**Annual Energy
Reduction Opportunity***



Through WEI, Wisconsin residents will benefit from the elimination of over 74,000 tons of pollutants from the atmosphere every year by the end of 1996.



Robert Brandherm, Secretary, State of Wisconsin Building Commission, is pleased with the project's outstanding results.

"The [WEI's] expedient implementation has resulted in hundreds of thousands of dollars of added energy savings each month...."

ROBERT BRANDHERM
Secretary
State of Wisconsin
Building Commission

The Savings

Efficiency is important, but state planners – and taxpayers – want to see the bottom line. The project surpassed its goals by completing many retrofits 18 months ahead of typical schedules.

"The expedient implementation of energy conservation projects has resulted in hundreds of thousands of dollars of added energy savings each month, without the loss of quality or an increase in overall project costs," Brandherm says.

In addition to saving money, WEI is adding private sector jobs, including hiring employees to administer the project and selecting mostly Wisconsin subcontractors and vendors to complete WEI work. Also, by saving energy, WEI is helping eliminate over 74,000 tons of power plant pollutants from the air each year by the end of 1996.

As governors and legislators realize the importance and benefits of energy efficiency, this innovative approach to saving energy has become a model for every state. Johnson Controls experience throughout the nation makes it the consultant of choice for coordinating multi-faceted energy management projects.



\$145 million will be saved by Colorado companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.

More ENERGY STAR Facts

- Colorado is home to 91 companies and public entities participating in ENERGY STAR partnerships.
- Over 91 million square feet of Colorado building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 2600 times the size of McNichols Arena.
- 1 ENERGY STAR-Labeled Product manufacturer is located in Colorado.
- Investments already made through the ENERGY STAR program in Colorado will prevent 3.5 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 490,000 acres of trees — an area 860 times the size of the University of Colorado-Boulder.
- Nitrogen oxide (NO_x) emissions will be reduced by 16 million pounds and sulfur dioxide (SO₂) by 17 million pounds due to existing ENERGY STAR investments in Colorado.

Highlights

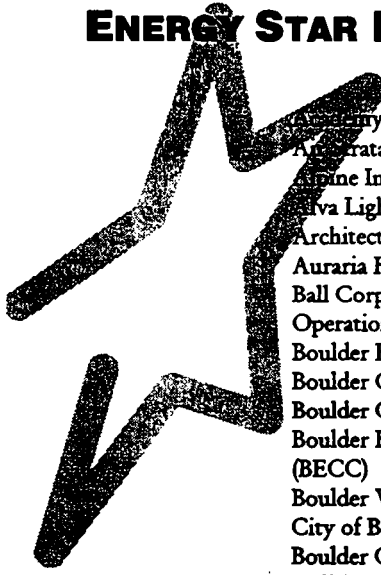
- City and County of Denver received the ENERGY STAR Buildings Government Partner of the Year Award in 1997.

Market Potential

- Colorado has 1 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$203 million would be saved annually
 - The following emissions would be prevented each year:
 - 4.5 billion pounds of CO₂
 - 25 million pounds of NO_x
 - 26 million pounds of SO₂

COLORADO

ENERGY STAR Participants in Colorado



Aurora School District 20
 Aurora LLC
 Bed & Breakfast
 Blue Lighting
 Architectural Energy Corporation
 Auraria Higher Education Center
 Ball Corporation, Metal Container
 Operations
 Boulder Bookstore
 Boulder Community Hospital
 Boulder County Clean Air Consortium
 Boulder Energy Conservation Center
 (BECC)
 Boulder Valley Public School District
 City of Boulder, Colorado
 Boulder County, Colorado
 Buffalo School District RE-4
 Building Performance Engineering
 Burke Associates Incorporated
 CAER Engineers, Incorporated
 CareerTrack
 Centennial Bolt, Inc.
 Children's World Learning Centers
 Chipotle Mexican Grill
 Coloradans for Clean Air
 Colorado Environmental Business
 Assistance Center
 Colorado Hospital Association
 Colorado Lighting
 Colorado State University System Office
 Conserve-A-Watt Lighting
 Craig Hospital
 Denver Metro Chamber of Commerce
 Denver Mineral Engr.
 The City & County of Denver,
 Colorado
 E Source, Inc.
 E-Technologies
 E2: Environment and Education
 EPA, Region 8
 EUA Cogenex
 Ecopreneur
 Etta Industries
 Financial Energy Management
 Fluorescent Maintenance Company
 Geotech Environmental Equip
 Geneva Pharmaceuticals
 Hunt Control Systems, Inc.
 Irwin Lodge Incorporated
 Jefferson County Public Schools,
 Lakewood
 John Newman School
 Leprino Foods
 Lewis Palmer School District
 Light Bulb Supply Company
 Lockheed Martin Holding Area
 Mountain House Victorians
 Mason Engineering, Inc.

McFall - Konkel & Kimball Consulting
 Engineers, Inc.
 Mobile Tool
 Normandy Farms & Stables Inc
 National Jewish Hospital
 Philips Electronics Industries (Taiwan)
 Ltd.
 Public Service Company of Colorado -
 Thermal Energy District
 Real Estate Auctioneering
 Restaurant Holding, Inc.
 Rocky Mountain Institute
 Rose Medical Center
 Ryall Electric Supply Company
 Saint Anthony's Parish
 ServiceMaster Energy Management
 Solvay Minerals, Inc.
 Southern Appalachian Man & the
 Biosphere Coop
 Stevens Aviation
 Storage Technology Corporation
 Student Envir. Action Coalition, Univ.
 of Denver
 TLBC The Little Bathrobe Co
 Tesser Consulting Group
 Tina Yee & Associates
 U.S. Department of Energy
 Colorado Army National Guard
 (State/Fed Space Included)
 Fort Carson, Headquarters
 National Park Service - Denver Service
 Center
 US West, Inc.
 Western Area Power Administration
 United Service Alliance
 University College Administration at
 University of Denver
 University Corp For Atmos Research
 University of Colorado Environmental
 Center at Boulder
 University of Denver
 The Wagner Group, Inc.
 Wall Technology, Incorporated
 Wastren
 Whitney Electric
 Wild Oats Community Market
 Windsor Gardens

Examples of Colorado Partners Saving Money and Helping the Environment

Boulder County

"[ESB/GL] was a natural progression from our existing energy conservation projects. The organized approach, technical assistance, and proven results of the Partnership helped us get approval for additional upgrades throughout the county's facilities."

— Ron Diederichsen, Facilities

Management Projects Coordinator

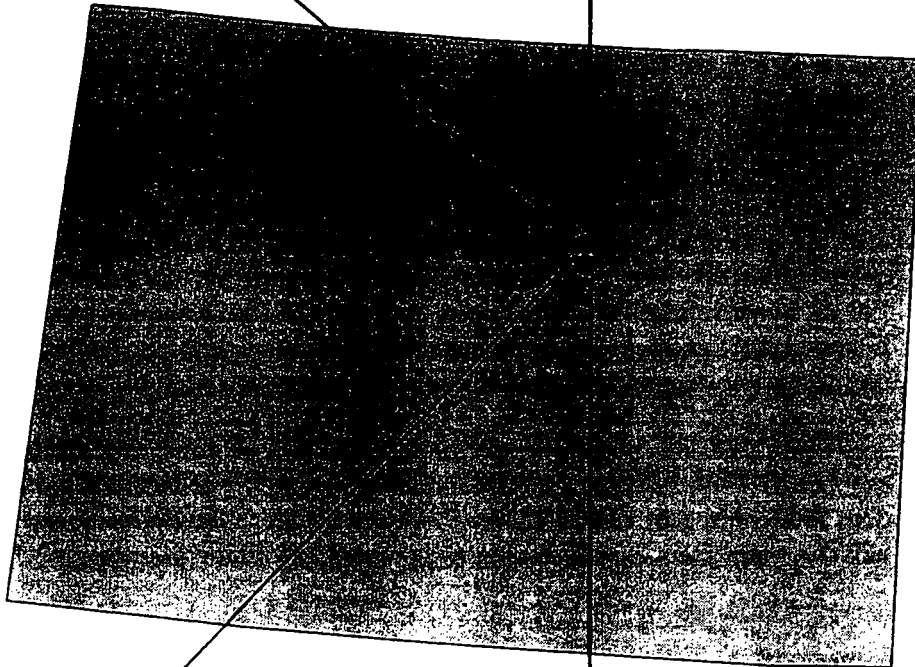
- Saving \$76,000 in annual energy costs
- Upgraded lighting for 1 million sq. ft.
- Reducing energy use by 1.1 million kWh annually
- Preventing 1.4 million pounds of CO₂ annually

City and County of Denver

"Energy efficiency directly benefits the constituents of our city by conserving resources, improving the environment, and saving taxpayer dollars. [The program helped us] complete upgrade projects faster and see the cost savings sooner."

— Darryl Winer, Utilities Director

- Saving \$498,000 in annual energy costs
- Upgraded 12.5 million sq. ft.
- Reducing energy use by 16.5 million kWh annually
- Preventing 19.8 million pounds of CO₂ annually



Lockheed Martin, Denver

- Saving \$1.3 million in annual energy costs
- Upgraded lighting for 26 million sq. ft.
- Preventing 38 million pounds of CO₂ annually

US West, Inc., Englewood

- Saving \$1.4 million in annual energy costs
- Upgraded lighting for 5.6 million sq. ft.
- Reducing energy use by 24 million kWh annually
- Preventing 29 million pounds of CO₂ annually
- Fostered corporate buy-in through communications outreach

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$9.5 billion and prevent 203 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3200 participants, representing more than one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. ENERGY STAR products that have already been purchased will save consumers over \$7 billion and prevent 130 billion pounds of CO₂.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Colorado

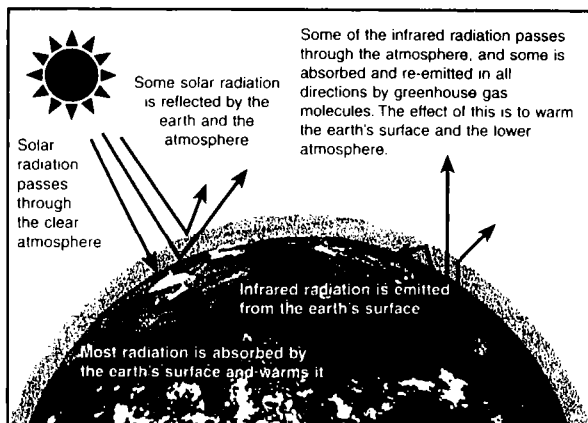
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today could not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, common air pollutants, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally.

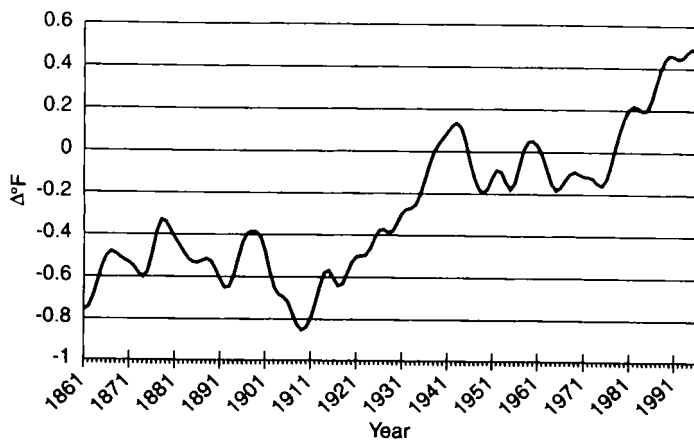
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***“the balance of evidence suggests a discernible human influence on global climate.”***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere's heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

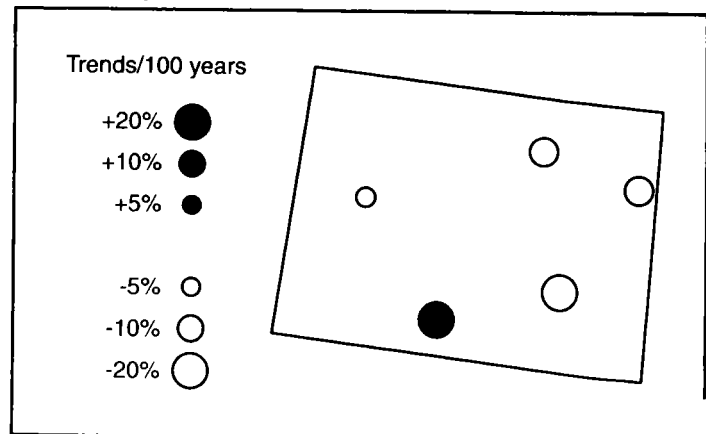
Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in Fort Collins, Colorado, has increased 4.1°F, and precipitation has decreased by up to 20% in many parts of the state.

Over the next century, climate in Colorado may change even more. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Colorado could increase by 3-4°F in spring and fall (with a range of 1-8°F) and 5-6°F in summer and winter (with a range of 2-12°F). Precipitation totals are estimated to change little in summer, although there could be an increase in the frequency of summer thunderstorms associated with moisture flow from the Gulf of Mexico. In spring and fall, precipitation is estimated to increase by 10%, and winter increases could have a range of 20-70%. Other climate models may show different results. The amount of precipitation on extreme wet or snowy days in winter is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

trend. Although it is not clear how severe storms would change, an increase in the frequency and intensity of winter storms is possible.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbon emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

Although Colorado is in compliance with current air quality standards, increased temperatures could make future compliance more difficult. Ground-level ozone has been shown to aggravate respiratory illnesses such as asthma, reduce existing lung function, and induce respiratory inflammation. In addition, ambient ozone reduces crop yields and impairs ecosystem health.

Warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases. A recent study has concluded that a 5-9°F temperature increase would cause a significant northern shift in Western equine encephalitis outbreaks. Mosquitos capable of transmitting this disease already are present in Colorado. If Colorado's climate becomes warmer and wetter, mosquito populations could increase and conditions may become more favorable for disease transmission.

In 1993, hantavirus pulmonary syndrome emerged in the Four Corners area. Ecological and climatic changes may have contributed to a tenfold increase in 1992-1993 in the deer mouse population, the primary reservoir for hantaviruses. Infection may have occurred because more people were exposed to the virus

allowing the increase in the deer mouse population, although this is still uncertain.

Water Resources

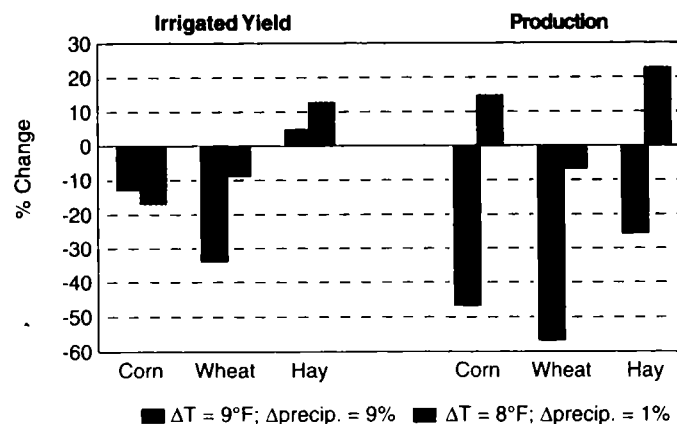
Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. If streamflow and lake levels drop, groundwater also could be reduced. In addition, more intense precipitation could increase flooding.

Colorado's rivers are used heavily both within Colorado and in downstream states. Most of the western third of Colorado eventually drains to the Colorado River, and the eastern two-thirds drains more or less equally to the Arkansas and Platte rivers. A small share drains into the Rio Grande. A warmer climate would lead to earlier spring snowmelt, resulting in higher streamflows in winter and spring and lower streamflows in summer and fall. Most of Colorado's reservoirs are small in relation to total runoff; therefore, earlier snowmelt could reduce the reliability of many water supply systems within the state by limiting the amount stored for use in summer. The reliability of water systems for downstream states (e.g., Arizona and California) in the Colorado basin, however, is protected by the large storage capacities in Lakes Powell and Mead. These effects could be mitigated if summer rainfall increases.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

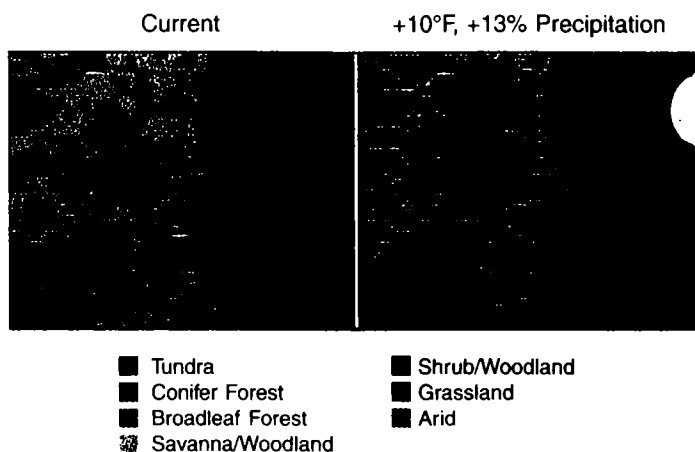
In Colorado, agriculture is a \$4 billion annual industry, three-fourths of which comes from livestock, mainly cattle. Almost half the crop acreage is irrigated. The major crops in the state are corn, wheat, and hay. Climate change could reduce grain yields 8-33%. Hay and pasture yields could fall by 6% or rise by 13%, depending on whether irrigation is used, leading to changes in acres farmed and production. For example, yields could fall while production rises because of an increase in acres farmed.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic range, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to these conditions, such as fir and spruce, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Colorado could change little or decline by as much as 15-30%. The uncertainties depend on many factors, including whether soils become drier and, if so, how much drier. Hotter, drier weather could increase the frequency and intensity of wildfires, threatening both property and forests. Along the Front Range, drier conditions would reduce the range and health of ponderosa and lodgepole forests, and increase their susceptibility to fire. Grasslands and rangeland could expand into previously forested areas in the western part of the state, and piñon-juniper forests in

Changes In Forest Cover



Source: VEMAP Participants (1995); Neilson (1995)

the southern part of the state could expand northward. Milder winters could increase the likelihood of insect outbreaks and of subsequent wildfires in the dead fuel left after such an outbreak. These changes would affect the character of Colorado forests and the activities that depend on them. However, increased rainfall could reduce the severity of these effects.

Ecosystems

Ecosystems in Colorado are diverse, ranging from grasslands and deserts to mountain shrublands, forests, meadows, and alpine tundra. They also include numerous wetlands and streams. Because of elevation changes and human land use, many habitats are fragmented and restricted in area. Changes in temperature and precipitation caused by climate change could affect the location and health of these ecosystems.

Warming could affect alpine areas, causing tree lines to rise by roughly 350 feet for every degree Fahrenheit of warming. Mountain ecosystems such as those found in Rocky Mountain National Park could shift upslope, reducing habitat for many subalpine species. Changes in rainfall and snowfall could alter streamflows and affect wetlands and wildlife, and possibly accelerate the invasion of non-native plants into streamside habitats. Aquatic species that are sensitive to water temperature could be affected adversely by climate change. Cold-water fish such as trout could lose important habitat in Colorado, and endangered species such as the Colorado squawfish could have difficulty adapting.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.





Climate Change Mitigation in Colorado

Colorado's Greenhouse Gas Emissions¹

- Greenhouse gas emissions from fossil fuel combustion in 1990 were about 21.5 million metric tons of carbon-equivalent, about 2% of the U.S. fossil fuel emissions for that year (U.S. Climate Action Report, U.S. Department of State, 1997).
- Per capita emissions from fossil fuel use in 1990 were 6.5 metric tons per person, greater than the 1990 national average of 5.3 metric tons per person.
- The major source of greenhouse gas emissions in Colorado was electric utilities, which accounted for about 46% of emissions.
- The second highest source of greenhouse gas emissions in Colorado was transportation, which accounted for about 30% of fossil fuel emissions.

Mitigation Policy Planning:

- Under a grant from the USEPA State and Local Climate Change Program, the Colorado Department of Public Health and Environment circulated the draft *Climate Change & Colorado: A Technical Assessment* for comment in September 1998. The document provides information about emissions in Colorado, potential impacts of climate change in Colorado, and a lengthy "Menu of Options" that can reduce Colorado's greenhouse gas emissions.

Existing Colorado Policies that reduce greenhouse gas emissions²:

Sample of Existing Policies or Programs:

- State Fleet efficiency standards
- Tax incentives for renewable energy systems
- Alternative Fuel Vehicle Rebate Program (Grant)
- Solar Access Laws
- Solar Contractor Training Programs
- Green Pricing Programs (Renewable Energy Trust, Solar Source, Wind Power Pilot Program, Windsource)
- Line Extension Analysis
- Net Metering availability
- Executive Order for the use of Renewable Energy by State Agencies (State Construction Policies)

Benefits of Reduced Reliance on Fossil Fuels: Increased opportunities for Colorado

Increases in renewable energy use and energy efficiency improvements would provide new economic opportunities for many industries. Those in some states already reap the benefits of reduced reliance on fossil fuels. For example, 33% of all U.S. solar collector shipments, valued nationally at \$29.8 million in 1996 (EIA Renewable Energy Outlook 1997), originated in California. Similar industries in Colorado could experience gains from a shift away from fossil fuels.³

Solar- and PV-related product and service providers in Colorado:

- *Companies include:* A B Mechanical in Littleton; A & D Master Solar Repair Service in Littleton, A. MacSwell Corporation in Pueblo; Abraham Solar Equipment in Pagosa Springs, Alpine Energy Products in Glenwood Springs, Alternative Heating Systems in Boulder, Architectural Energy Corporation in Boulder, and Aspen Solar Systems, in Aspen, Atlasta Solar And Energy in Fruita, and Atlasta Solar And Energy in Grand Junction.

Wind-related product and service providers in Colorado:

- *Companies include:* Aerofire Inc. in Lafayette, Aerogen Technology Inc. in Denver, and Alternative Choices in Florence.

Energy Efficiency-related product and service providers in Colorado:

- *Companies include:* Atlas Arkology A Sustainable Living Institute in Placerville.

\$197 million will be saved by Minnesota companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



More ENERGY STAR Facts

- Minnesota is home to 95 companies and public entities participating in ENERGY STAR partnerships.
- 202 million square feet of Minnesota building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 240 times the size of the Target Center.
- 6 ENERGY STAR-Labeled Product manufacturers are located in Minnesota.
- Investments already made through the ENERGY STAR program in Minnesota will prevent over 7 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 955,000 acres of trees — an area over 1070 times the size of the University of Minnesota-Twin Cities.
- Nitrogen oxide (NO_x) emissions will be reduced by over 20 million pounds and sulfur dioxide (SO₂) by 41 million pounds due to existing ENERGY STAR investments in Minnesota.

Highlights

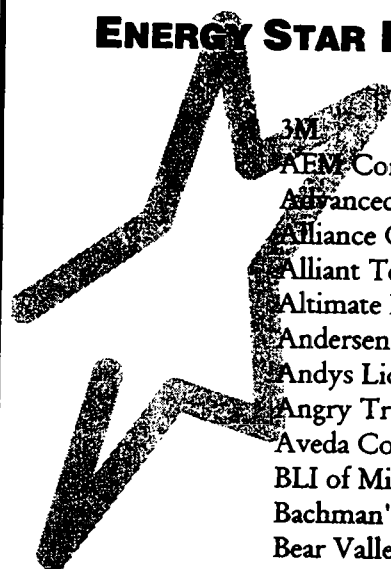
- Andersen Corporation (Bayport) received the ENERGY STAR Homes Manufacturer of the Year Award and the ENERGY STAR Windows Partner of the Year Award in 1999 and the ENERGY STAR Homes Manufacturing Ally of the Year Award in 1998.
- Honeywell Incorporated received the ENERGY STAR Buildings Partner of the Year Award in 1997, the ENERGY STAR HVAC Manufacturer of the Year Award in 1996, and the Green Lights Ally of the Year Award in 1995.
- One of Minnesota's landmark buildings, the Trane Company's St. Paul facility, has expressed its commitment to being among the top 25 percent in energy performance nationally.

Market Potential

- Minnesota has 1.3 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$276 million would be saved annually
 - The following emissions would be prevented each year:
 - 7 billion pounds of CO₂
 - 32 million pounds of NO_x
 - 89 million pounds of SO₂

MINNESOTA

ENERGY STAR Participants in Minnesota



3M
 AEM Corporation
 Advanced Microbial Systems
 Alliance Container
 Alliant Techsystems, Inc.
 Altimate Medical
 Andersen Corporation
 Andys Liquor
 Angry Trout Café
 Aveda Corporation
 BLI of Minnesota
 Bachman's Incorporated
 Bear Valley Electric, Inc.
 Border States Electric Supply
 C.O. Brown Agency, Inc.
 Canadian Honker Restaurant
 Cannon Falls Community Hospital
 Citilights Lighting, Inc.
 Containment Technologies
 Dana's Apparel
 Danco Food & Entertainment/Circus Pizza
 Danco Food & Restaurant/Circus Pizza
 Dayton Hudson Corporation Department
 Stores Division
 Deluxe Corporation
 Digital Power Company, Inc.
 Donaldson Company, Inc.
 City of Duluth, Minnesota
 Econar Energy Systems Corporation
 Environmental Technology & Education
 Elks Lodge 1091
 Energy Masters International, Inc.
 Environmental Property Audits
 Fred's Super Value
 Fairmont School District
 Fairview Southdale Hospital, Minneapolis
 Fargo Electronics, Incorporated
 Fast Source
 First Lighting
 Flatwater Fleet Inc
 Foam Enterprises, Inc.
 HB Fuller Company
 Hardys Bar-B-Q
 Homestead United Methodist Church
 Honeywell Incorporated, Maple Grove
 Honeywell Incorporated, Bloomington
 IBM Mid America Credit Union
 Independent School District 625
 JH Larson Electrical Company

John B. Goodman Limited Partnership
 Judisch Photo and Electronics
 Littlefork IGA
 Labno Environmental
 The Lighting Resource
 Luther Seminary
 Mercury Technologies of Minnesota, Inc.
 Minneapolis Pub Schools & Spec Dist #1
 Minnehaha Lodge #165 AF&AM
 Minnesota Chamber of Commerce
 Minnesota Environmental Initiative
 Minnesota Hospital and Healthcare
 Partnership
 Minnesota Mutual Life Insurance Company
 Minnesota Public Interest Research Group
 Mitor Industries, Inc.
 Moorhead Public Service
 Muska Lighting Center
 Northome IGA Store
 Nation's Business
 North Memorial Health Care
 North Plaza Developers LLC
 Northern States Power Company
 Northstar Diversified Technologies
 Northstar Financial Forms
 Owens Companies, Inc.
 Paddock School of Horsemanship, Inc.
 Quillin's IGA, Inc.
 Recyclights
 Redwood Falls Hospital
 Riverwood Healthcare Center
 Robert G. Suk Law Office PA
 Sunnyside Little Store
 St. Paul Fire and Marine Insurance
 The City of St. Paul, Minnesota
 Science Museum of Minnesota
 SoilPure Inc
 Suburban Lighting, Inc.
 SuperValu Stores, Inc.
 Target Stores
 Terra Resources Inc.
 Thatcher Pools & Spas Inc.
 Trane Worldwide Applied Systems Group
 United Energy Companies, Inc.
 United Hospital (Childrens Hospital)
 University of Minnesota-Twin Cities
 Ward and Oehler Limited
 Waseca Independent School District 829

Examples of Minnesota Partners Saving Money and Helping the Environment

Honeywell, Minneapolis

"[Energy Star Buildings is the next logical step for Honeywell in energy efficiency. These] technologies that help the environment are the key to our future."

— Michael Bosignore, Chairman and CEO

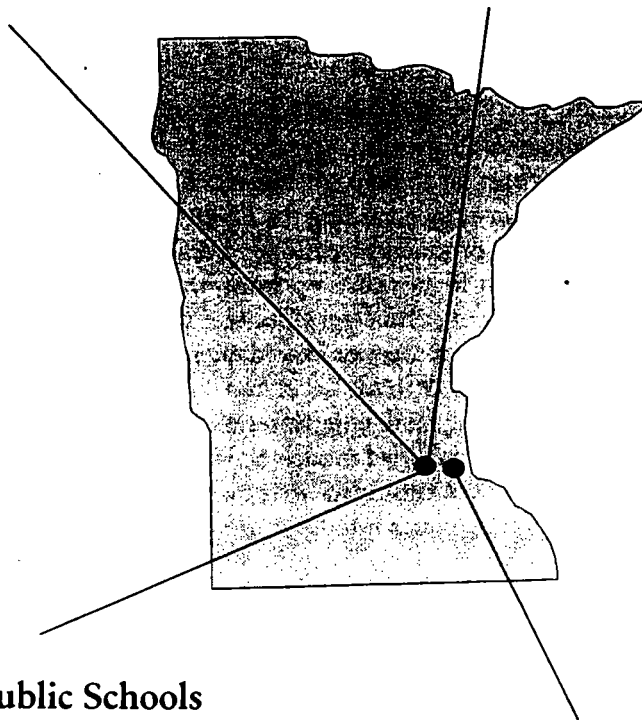
- Saving \$1.6 million in annual energy costs
- Upgraded 100% of 9.8 million sq. ft.
- Reducing energy use by 28 million kWh annually
- Preventing 47 million pounds of CO₂ annually

Target, Minneapolis

"[In addition to implementing energy saving upgrades in existing facilities,] energy efficiency is a key consideration in the construction of new stores. Target is also experimenting with even more advanced technologies, such as skylights combined with daylight dimming controls, to further improve building comfort and reduce energy costs."

— Jim Boler

- Saving \$1.5 million in annual energy costs
- Installed occupancy sensors in 723 stores
- Reducing energy use by 16.6 million kWh annually
- Preventing 23 million pounds of CO₂ annually
- Planning to upgrade a total of over 100 million sq. ft. by 2000



Minneapolis Public Schools and Special District #1

- Saving \$580,000 in annual energy costs
- Upgraded 5.9 million sq. ft.
- Reducing energy use by 8.2 million kWh
- Preventing 16.2 million pounds of CO₂ annually

St. Paul Fire and Marine Insurance, St. Paul

- Saving \$52,000 in annual energy costs
- Completed lighting upgrades for 1.5 million sq. ft.
- Reducing energy use by 900,000 kWh annually
- Preventing 1.6 million pounds of CO₂ annually

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$3.5 billion and prevent 78 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3000 participants, representing close to one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. Consumers are now saving over \$1 billion a year by bringing ENERGY STAR products into their homes.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Minnesota

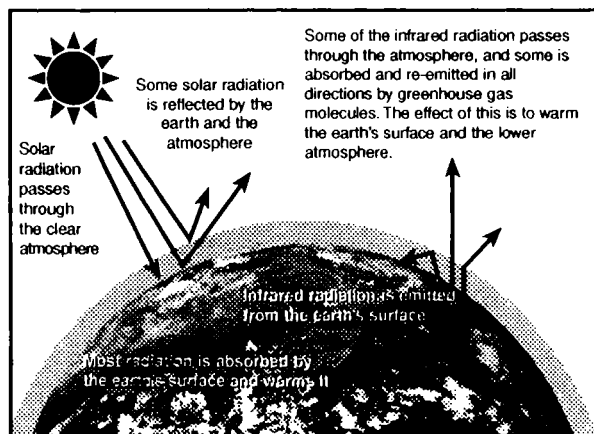
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

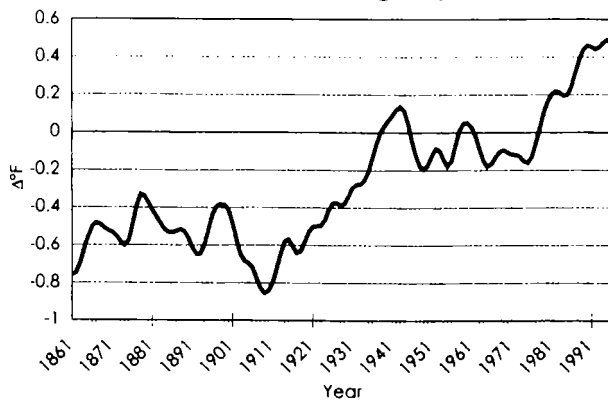
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Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F since the late 19th century. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that *“the balance of evidence suggests a discernible human influence on global climate.”*

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as

well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in Minneapolis, Minnesota, has increased slightly from 43.9°F (1888-1917 average) to 44.9°F (1963-1992 average), and precipitation in some areas of the state has increased by up to 20%, especially in the southern half.

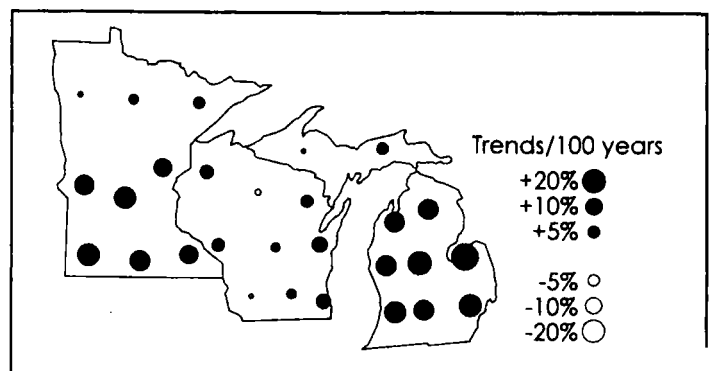
Over the next century, Minnesota’s climate may change even more. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that has accounted for both greenhouse gases and aerosols, it is projected that by 2100, temperatures in Minnesota could increase by about 4°F (with a range of 2-7°F) in winter, spring, and fall, and by somewhat less in summer. Precipitation is projected to increase by around 15% in winter, summer, and fall, with little change projected for spring.

The amount of precipitation on extreme wet days in summer may likely would increase. The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms would change.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Minnesota, with its irregular, intense heat waves, seems somewhat susceptible.

In Minneapolis, one study projects that a 3°F warming could triple heat-related deaths from 60 during a typical summer to about 180 (although increased air conditioning use may not have been fully accounted for). The elderly, particularly those living alone, are at greatest risk.

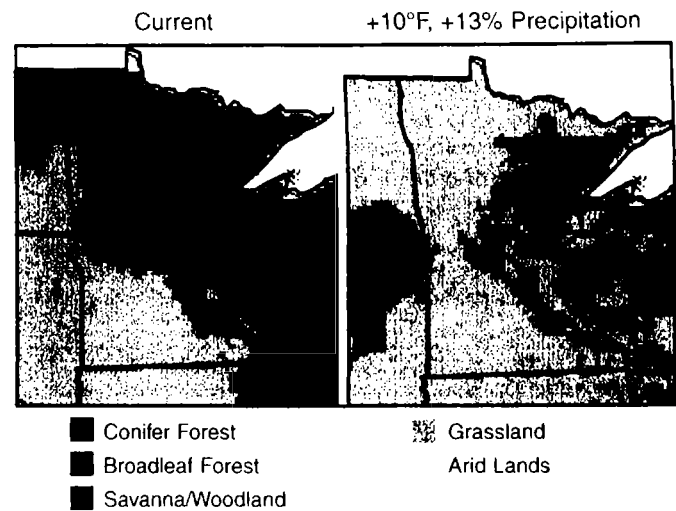
Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects, increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitoes flourish in Minnesota, and some carry St. Louis encephalitis. The mosquito populations that carry this disease could increase with climate change. Also, the mosquitoes carry yellow fever, dengue fever, Eastern equine encephalitis, and La Crosse encephalitis recently have spread as far north as Chicago. Global warming could shift the region where these mosquitoes breed and overwinter farther north. If conditions become warmer and wetter, mosquito populations can increase, thereby increasing the risk of transmission of these diseases.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to warmer conditions, such as oaks and southern pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in Minnesota would change little or decline by as much as 50-70%. The uncertainties depend on many factors, including whether soil

Changes In Forest Cover



Source: VEMAP Participants (1995); Neilson (1995)

becomes drier and, if so, by how much drier. Hotter, drier weather could increase the frequency and intensity of wildfires. The unique boreal forests in the northern part of the state and in the Boundary Waters Canoe Area could be replaced by mixed forests better adapted to warmer conditions. The mixed aspen, birch, beech, maple, and pine forests in the northern and eastern areas of the state would shrink in range and be replaced by a combination of grasslands and hardwood forests consisting of oak, elm, and ash. Grasslands and savanna eventually could replace much of the forests and woodlands in the state. These changes would significantly affect the character of Minnesota forests and the activities that depend on them.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

Minnesota is known as the "Land of 10,000 Lakes." About two-thirds of the state lies within the headwaters of the Mississippi River. The remainder is drained by the Red River and small tributaries of Lake Superior. If climate warms, the ice cover on Minnesota's lakes and streams would not last as long as it does today. Streamflows could peak sooner in the spring because of earlier snowmelt and ice breakup. Reduced summer flows could decrease water quality. Lake surface temperatures would be warmer in the summer, although the temperature changes generally would be less than the increase in air temperature. As a result, lake evaporation would increase considerably, perhaps by as much as 20% for a 4°F warmer climate.

Shorter ice-cover seasons and increased lake evaporation could have major effects on Lake Superior. Fresh water flowing into Lake Superior could decrease with global warming, potentially reducing lake levels and degrading water quality. Flood damage could be reduced, but shorelines could be more susceptible to erosion damage from wind and rain. Reduced fresh water in the Great Lakes could negatively affect shipping to and from Duluth, for example, primarily because of lower water levels in the shipping channels connecting the lower Great Lakes. However, this could be offset by a longer ice-free season.

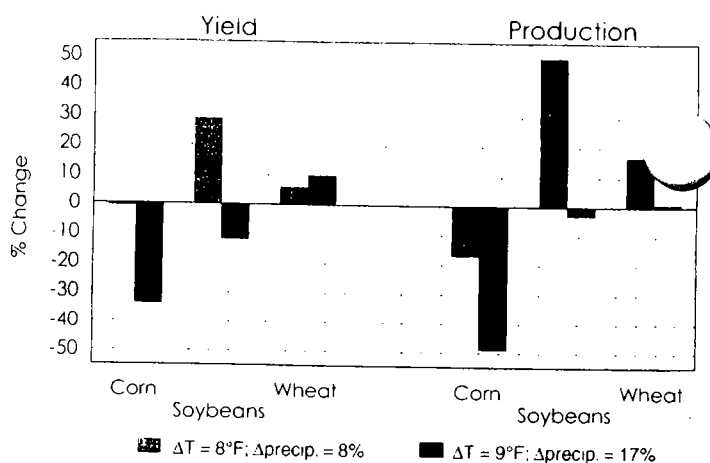
Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

In Minnesota, agriculture is about a \$7 billion annual industry, 50% of which comes from crops. About 5% of all farm acres in the nation is in Minnesota. The principal crops are corn, soybeans, and wheat. About 2% of the state's farm acres are irrigated. If climate warms, corn yields could remain unchanged or could decrease by up to 34%. Wheat yields could increase by 6-10%, and projected soybean yields are mixed: they could increase by up to 28% or decrease by 12%. The number of acres farmed could fall by 12-18%, and farm income could decrease by

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

10-25%. Irrigated acreage could increase. This could further stress water supplies, which could be lower in the summer, and water quality could be degraded further.

Ecosystems

The prairie potholes of Minnesota are the single most important breeding area for North American waterfowl such as mallards, pintails, and blue-winged teals. The drying effects of climate change could reduce the size and number of prairie potholes, damaging effects to the waterfowl.

The forest ecosystems in the Boundary Waters Canoe Area are an important habitat for Kirtland's warblers. If the birch, balsam fir, white cedar, and quaking aspen found there were replaced by sugar maples, Kirtland's warblers could disappear in Minnesota.

Aquatic ecosystems also could be affected by climate change; for example, brown trout could lose most of their habitat.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.

 \$106 million will be saved by Oregon companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



OREGON

More ENERGY STAR Facts

- Oregon is home to 43 companies and public entities participating in ENERGY STAR partnerships.
- Over 104 million square feet of Oregon building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area over 130 times the size of the Rose Garden.
- 1 ENERGY STAR-Labeled Product manufacturer is located in Oregon.
- Investments already made through the ENERGY STAR program in Oregon will prevent over 2 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 272,000 acres of trees — an area 970 times the size of the University of Oregon.
- Nitrogen oxide (NO_x) emissions will be reduced by over 760 million pounds and sulfur dioxide (SO₂) by 850 million pounds due to existing ENERGY STAR investments in Oregon.

Highlights

- St. Charles Medical Center (Bend) received the Green Lights Small Hospital Partner of the Year Award in 1996.
- Colonial Pacific Leasing Corporation received the Green Lights Small Business Partner of the Year Award in 1996.

Market Potential

- Oregon has 940 million square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$219 million would be saved annually
 - The following emissions would be prevented each year:
 - 4.7 billion pounds of CO₂
 - 2 million pounds of NO_x
 - 3.5 million pounds of SO₂

ENERGY STAR Participants in Oregon



A. K. E. A.
Albany General Hospital
Bay Area Hospital
Bonneville Power Administration
Cherry City Electric Lighting Services
Citizen's Photo
Colonial Pacific Leasing
Douglas County, Oregon
Downunder Leather
Entertainment Technology, Inc.
Eoff Electric Company
Epson Portland Inc.
City of Eugene, Oregon
Fred Meyer
GFL Lighting Incorporated
Good Samaritan Hospital (Oregon)
Hudson Insurance
Jantzen, Inc.
Kaiser Permanente-Northwest Region
Lane Community College
Mt. Bachelor Ski & Summer Resort
Multnomah County, Oregon
Nike, Inc.
Northwest Power Planning Council
OECO Corporation
Oregon Institute of Technology
Oregon School Facilities Management
Association
OR Society for Hospital Engineering
Oregon State Superintendent of Public
Instruction

The State of Oregon
Pacific Power
Platt Electric Supply
Portland General Electric Company
Portland Public Schools
The City of Portland, Oregon
St. Charles Medical Center
St. Vincents Hospital (OR)
Southern Oregon University
Springfield Utility Board
Taylor Electric Supply, Inc.
Thrifty/Payless Incorporated
US Bancorp
Utah Power (Oregon Division)

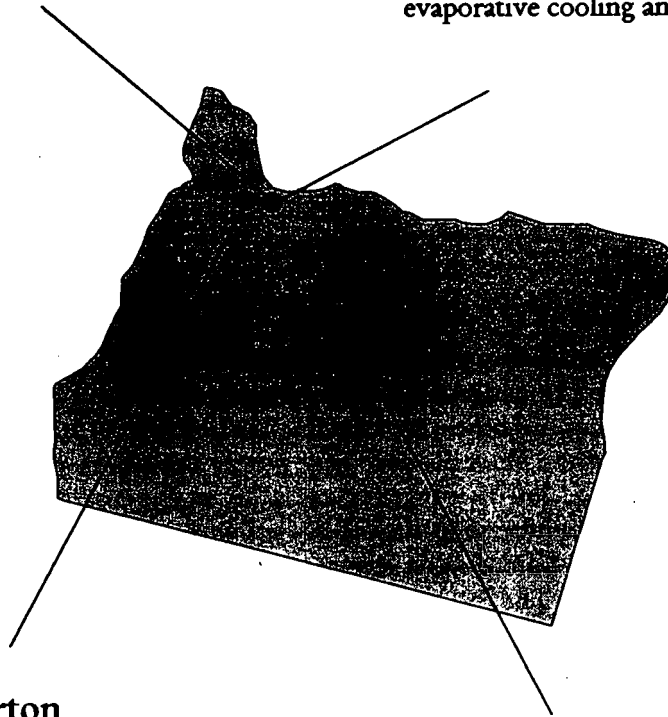
Examples of Oregon Partners Saving Money and Helping the Environment

The City of Portland

- Saving \$136,000 in annual energy costs
- Upgraded over half of its local government buildings
- Reducing energy use by 3.2 million kWh annually
- Preventing 2.5 million pounds of CO₂ annually

Portland Public Schools

- Saving \$113,000 in annual energy costs
- Savings prevented the loss of 15 jobs in 1998
- Preventing 14 million pounds of CO₂ annually
- Installed energy management systems, improved air ducts and insulation, and used energy-efficient office equipment
- Created an "Earth Smart" model school incorporating state-of-the-art equipment such as evaporative cooling and low-tech savings options



Nike Inc., Beaverton

- Saving \$59,000 in annual energy costs
- Upgraded lighting for 1 million sq. ft.
- Reducing energy use by 1.2 million kWh
- Preventing 2 million pounds of CO₂ annually
- Committed to upgrading over 3.6 million sq. ft.

St. Charles Medical Center, Bend

"It is important for hospitals to cut their operating costs through better energy management, and to do it with EPA's help just makes sense. Energy Star Buildings and Green Lights is a win-win situation."

— Mike Severns, Director of Facility Services

- Saving \$38,000 in annual energy costs
- Upgraded 100% of its 330,000 sq. ft.
- Reducing energy use by 3.7 million kWh annually
- Preventing 350,000 pounds of CO₂ annually
- Installed occupancy sensors, an energy management system, and energy-efficient technologies and office equipment

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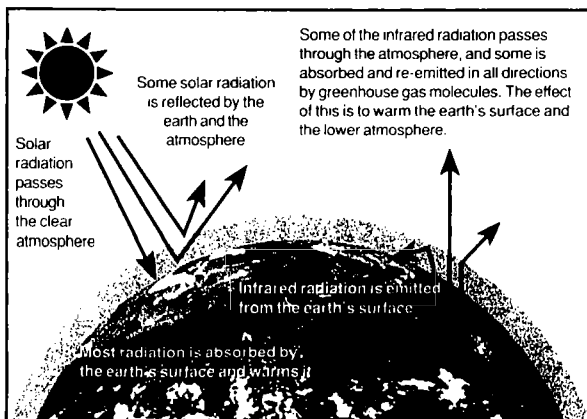
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The Greenhouse Effect



Source: U.S. Department of State (1992)

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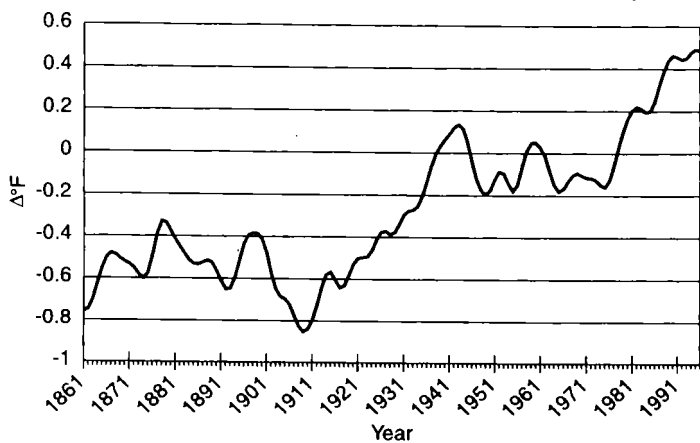
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The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as

well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

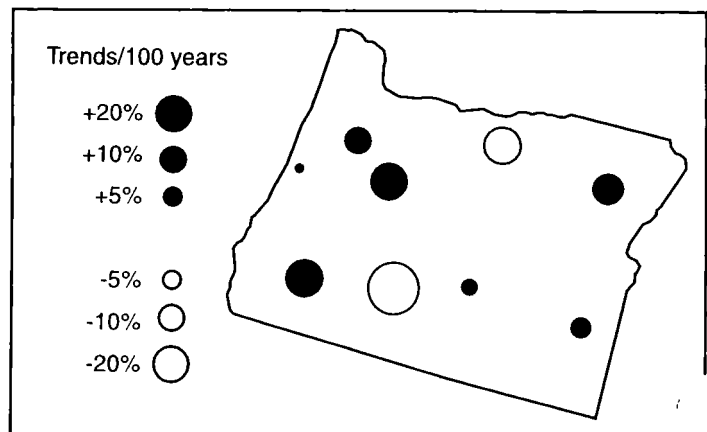
Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in Corvallis, Oregon, has increased 2.5°F, and precipitation has increased by up to 20% in many parts of the state, except along the leeward side of the Cascades where precipitation has fallen by 20%. These past trends may or may not continue into the future.

Over the next century, climate in Oregon may change even more. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Oregon could increase by 5°F (with a range of 2-9°F) in winter and summer and 4°F (with a range of 2-7°F) in spring and fall. Precipitation is estimated to increase slightly in spring (with a range of 0-10%), decrease slightly in summer (with a range of 0 to -10%), and increase by 15% in fall and winter (with a range of 5-25%). Other climate models may show different results, especially regarding estimated changes in precipitation. The impacts described in the sections that follow take into account estimates from different models. The amount of precipitation on extreme wet or snowy days in winter is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. It is not clear how the severity of storms might be affected, although an increase in the frequency and intensity of winter storms is possible.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Oregon, with its occasional, intense heat waves, may become more susceptible if its climate changes. In Portland, heat-related deaths are estimated to increase by nearly 150% given a summer warming of 4°F (although increased air conditioning use may not have been fully accounted for). The elderly, especially those living alone, are at greatest risk. This study also projects little change in winter-related deaths in Portland if the temperature warms by 2-3°F.

Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Warmer temperatures could increase the incidence of Lyme disease and other tick-borne diseases in Oregon, because populations of ticks, and their rodent hosts, could increase under warmer temperatures and increased vegetation.

St. Louis and California encephalitis are present in California, and some studies indicate that these diseases could move north under a warmer climate. Western equine encephalitis has also been found in domestic animals in Oregon. Mosquitoes can carry these diseases, which can be lethal or cause neurological damage. If conditions become warmer and wetter, mosquito populations could increase, thus increasing the risk of transmission if these diseases, as well as malaria, are introduced into the area. Increased runoff from heavy rainfall could increase water-borne diseases such as giardia and cryptosporidia.

Developed countries such as the United States should be able to minimize the impacts of these diseases through existing disease prevention and control methods.

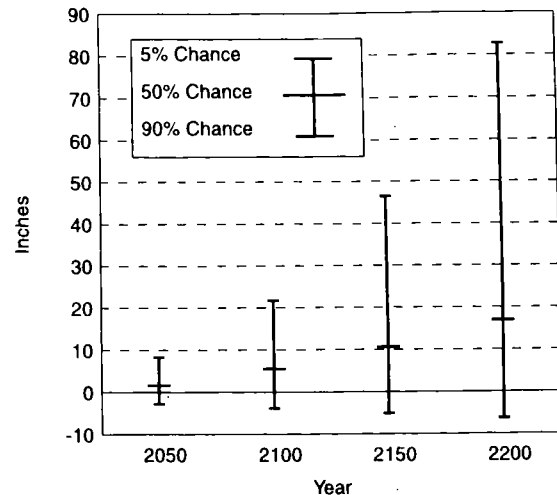
Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

Oregon has a 1,400-mile tidally influenced shoreline that consists mostly of steep slopes, pocket beaches, and small embayments, with a few natural coastal plains. The steep, rocky cliffs that dominate most of the coastline limit vulnerability to sea level rise. Coastal marshes in Oregon are limited to the Tillamook and Coos Bay regions. Under a sea level rise of 1-3 feet, the salt marshes along these bays and harbors could be lost (although some migration onto undeveloped lowlands could partially offset losses).

Evidence suggests that uplift may help mitigate the effects of sea level rise on the Oregon coast. Along much of the coast, land is being uplifted as a result of tectonic activity at approximately 4 inches per century. However, sea level rise could reverse that

Future Sea Level Rise At Yaquina



Source: EPA (1995)

trend. Accounting for sea level rise from climate change, sea level on the Oregon Coast is estimated to rise 6 inches by 2100. Nonetheless, the rocky shore of Oregon may limit erosion, and help protect the coastline. The cumulative cost of sand replenishment to protect the coast of Oregon from a 20-inch sea level rise by 2100 is estimated at \$60-\$920 million.

Water Resources

Runoff in Oregon is highly variable, and summer flows are often low. Reservoir storage is used throughout the state to augment summer flows with captured winter and spring runoff. Major regulated rivers include the Columbia along the northern border, the Snake along the northeast border, and the Willamette.

Some models for the Pacific Northwest project warmer, wetter winters and warmer, drier summers. In the mountains, warmer winter temperatures could mean less snowfall, more winter rain, and a faster, earlier snowmelt. More rain and greater streamflow, particularly during the winter, could benefit hydropower production and water supplies, but also could increase flooding in some areas. In the rainfall-dominated rivers in the west, projected changes result in increased winter streamflows and decreased summer streamflows. Because of limited storage capacity, there could be lower reservoir and water supplies in the summer and fall. Less water would be available to reliably support important uses such as hydropower production, fish protection, irrigation, recreation, and water supply. Oregon is a major producer of hydropower, and lower flows could affect its ability to meet energy production requirements, particularly during critical low flow periods. Provision of adequate water for fish protection is also an important issue. In rivers such as the Columbia, instream flow requirements are difficult to meet because of the limited storage available to support them. Similarly, in heavily allocated basins such as the Snake River, current irrigation demand cannot always be met. The public also demands high lake levels in the summer for recreation. Lower streamflows and lake levels would exacerbate current stresses and increase competition among water uses. Additionally, lower summer flows and higher temperatures could impair water quality by concentrating pollutants and reducing the ability of streams to assimilate wastes.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other users.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, crop pests, changes in air pollution such as ozone, and adaptation by farmers to changing climate. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

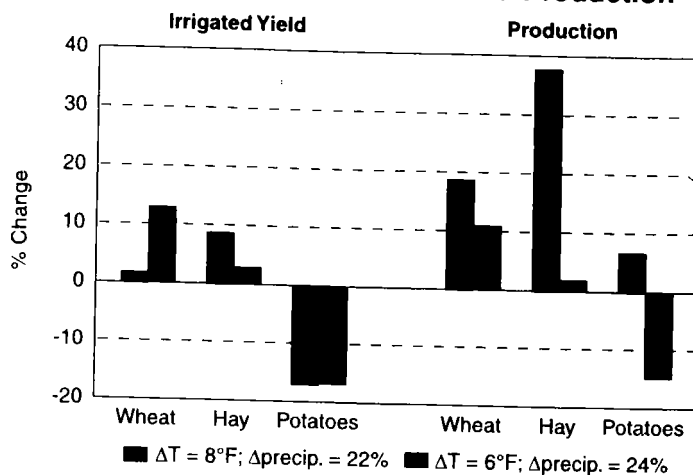
In Oregon, production agriculture is a \$2.5 billion annual industry, three-fourths of which comes from crops. Almost one-half of the farmed acres are irrigated. The major crops in the state are wheat, hay, and potatoes. Climate change could increase wheat yields by 2-13%. Hay and pasture yields could rise by 10% or fall by 7%, depending on how climate changes and whether irrigation is used. Potato yields could fall by 17% as temperatures rise beyond the tolerance level of the crop. Farmed acres could remain fairly constant or could decrease by as much as 23%.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species composition, geographic range, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture (or in some forests lead to changes in the types of trees that flourish). Even a warmer and wetter climate could lead to changes; trees that are better adapted to these conditions, such as hemlock and sitka spruce, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if the change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate. Commercial timber production could also be affected by resulting changes in growth rates, plantation acreage and management, and market conditions.

With changes in climate, the extent of forested areas in Oregon could change little, or they could decline by 15-25%, primarily east of the Cascades. The uncertainties depend on many factors, including whether soils become drier and, if so, how much drier. Hotter, drier weather could increase the frequency and intensity of wildfires, threatening the important timber-producing areas of the state. In the state's highly productive conifer forests, drier conditions would favor Douglas fir, lodgepole pine, and ponderosa pine forests at the expense of the wet-loving hemlock and

Changes In Agricultural Yield And Production



Sources: Mendelsohn and Neumann (in press); McCarl (personal communication)

sitka spruce along the coast. Warmer conditions could increase the elevation of the timberline, resulting in a reduction or the disappearance of alpine tundra and its unique (and in some cases already endangered) species. These changes could affect the character of Oregon forests and the activities that depend on them.

Ecosystems

Lower streamflow in the hot summer months would have negative consequences for fish populations in Oregon waters, which are already under pressure from dams and other human disturbances. Less summer and fall runoff could affect salmon migration and spawning. More flooding and winter runoff could alter sedimentation processes in rivers and streams, perhaps harming fish habitat and decreasing egg-smolt survival. Warmer water temperatures affect dissolved oxygen concentrations, which could decrease the survival rate, reproduction, and growth of certain fish, perhaps favoring the increased range expansion of exotic species at the expense of native species. Changing aquatic ecosystem conditions could result in a general northward shift of species distributions. Populations at the extremes of their range will be those most susceptible to change.

As low-lying coastal areas are gradually squeezed between rising sea levels and coastal development, a permanent loss of terrestrial coastal habitats is expected. Changes in offshore upwelling could cause changes in nutrient supplies, which could have adverse impacts for anadromous fish such as salmon. The rangelands of the Great Basin are already imperiled by the expansion of non-native weedy species such as European cheatgrass. Climate change could exacerbate such threats, because opportunistic non-native species are well-suited to take advantage of ecosystem disturbances caused by warming temperatures, such as increases in the frequency and severity of wildfires.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460, or visit <http://www.epa.gov/globalwarming/impacts>.

EPA Climate Change

Oregon Switches to Cleaner Power

Utilities and power plant developers across the nation can play a significant role in slowing global climate change. In 1996, Oregon took an important step in this direction when it approved the construction of a power plant that incorporates measures to offset its emissions of carbon dioxide, an important greenhouse gas. The new plant will be located in Klamath Falls in southern Oregon.

In 1997, Oregon went even further and enacted a landmark law that establishes a "carbon dioxide standard" for all new power plants of 25 megawatts or more. The CO₂ standard requires natural gas-fired plants to achieve 0.7 pounds of CO₂ emissions for each kilowatt-hour of power produced—a reduction of 17 percent below the most efficient gas-fired plant currently operating in the United States. The standard can be met by any combination of efficiency, cogeneration, and offsets from off-site mitigation.

In addition to efficiency, the Klamath Falls plant will offer the following portfolio of mitigation measures:

- A high-efficiency generator for *cogeneration* of steam that will be used by a lumber mill for kiln-drying lumber.
- *Reforestation* of 6,250 acres of Douglas fir in western Oregon.
- Expansion of *geothermal district heating* in the town of Klamath Falls to 78 additional buildings.

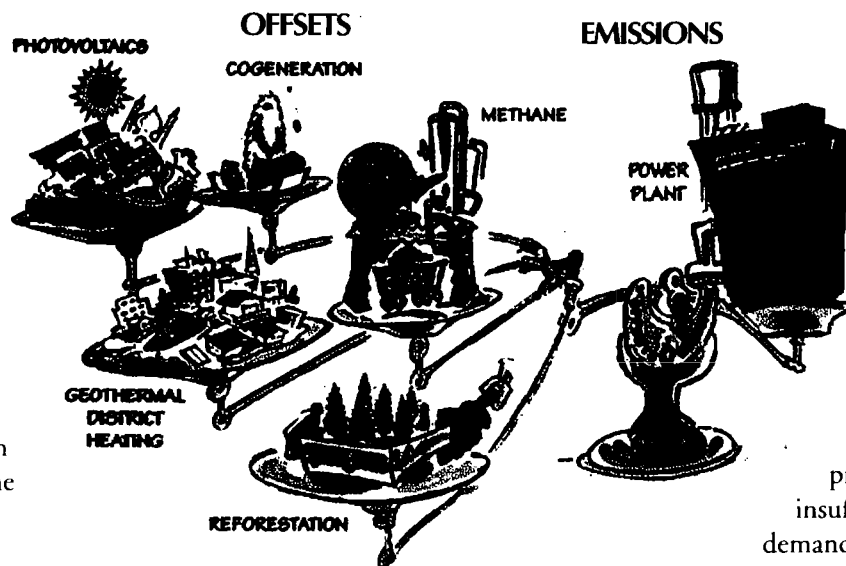
- Generation capacity of 32 megawatts from waste *methane* recovered from sewage treatment plants and coal mines in the United States.
- Capital support to install 182,000 20- or 35- watt *photovoltaic* systems over a 30-year period in remote households in India, China, or Sri Lanka to provide electricity to replace kerosene lamps.

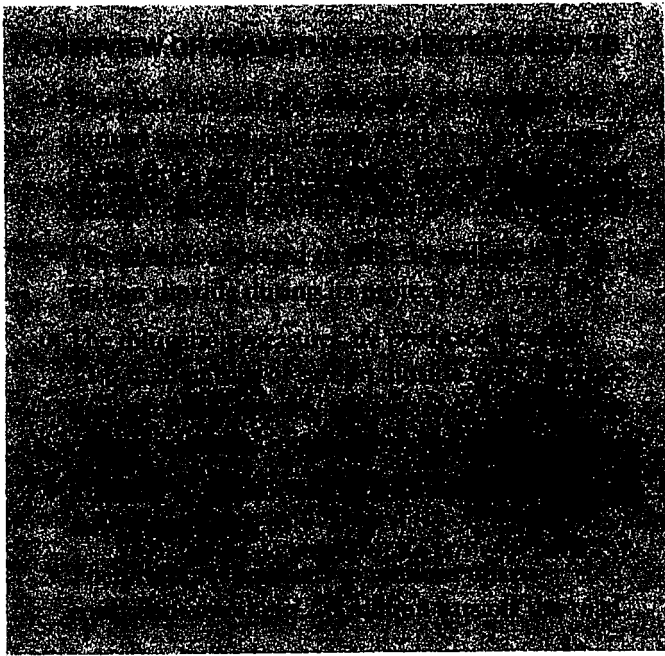
According to the Oregon Energy Facility Siting Council, this is the first time in the United States that global warming has played a role in a major decision regarding the regulation of energy resources.

Historical Background

In 1971 Oregon passed a state law regulating the certification of new energy facilities. The law established a requirement that developers of new power plants must prove the need for a new facility. This "need for facility" or "need for power" standard required utility developers to demonstrate that present supply is insufficient to meet energy demand as shown in utility least-cost plans. A number of additional requirements must be met as well, including financial, public safety, and environmental standards such as impacts on wildlife refuges and other protected areas.

Very few power plants were constructed in Oregon during the 1980s. By 1995, representatives of the utility industry had persuaded legislators to introduce a bill that





would eliminate the need for power standard. When it appeared that the governor would veto the bill, a one-time-only exemption was approved instead. Oregon's Energy Facility Siting Council established a competition to select a company to receive the exemption. At the same time, the governor and legislature created a task force to review the process of siting power plants.

The Klamath Cogeneration Project

The Klamath Cogeneration Project won the competition for the one-time exemption from the need for power standard. The competition was based on a comparative evaluation of proposed plants' environmental impacts on air, water, and land resources.

The first test was for air emissions of carbon dioxide, nitrogen oxides, and particulate matter. To rank the proposed projects, tons of emissions per kilowatt-hour were multiplied by a cost value for each pollutant in an effort to internalize environmental costs. The test employed values of \$10 per short ton of carbon dioxide and \$2,000 per short ton of nitrogen oxides and particulates.

Klamath, which received its final site certification in August 1997 and expects to begin construction in the next two years, is committing \$3.1 million to its off-site mitigation projects. It also expects to raise \$1.5 million in matching funds for the reforestation project. The offset projects, along with the steam cogeneration,

should offset 11.6 million tons of carbon dioxide over a period of 100 years, well beyond the 30-year lifetime of the plant. The offsets will equal a third of the plant's expected emissions—and would be even more if the methane benefits were factored in. The carbon dioxide offsets over 100 years are equivalent to taking 2.6 million cars off the road.

Lessons Learned

The competition encouraged innovation

The competition encouraged a diversity of proposals for innovative offset measures. One of the two losing competitors, for example, proposed guaranteed sequestration of 1.1 million tons of carbon dioxide through conservation easements intended to extend the average life of protected forests. Unlike the Klamath project, which offset carbon dioxide emissions through new tree plantings, this proposal offered offsets from managing growth in existing forested areas. Managing existing forests is intended to ensure that those trees will continue to sequester carbon dioxide.

The other applicant proposed a mitigation fund of \$7.5 million without specifying measures. The council selected the Klamath package because it had significantly greater offsets. It also offered greater innovation, cogeneration, reforestation, geothermal heating, methane recovery, and photovoltaics.

The offset projects, along with the steam cogeneration, should offset 11.6 million tons of carbon dioxide over a period of 100 years.

The council required guarantees of offsets in those areas that are within the developer's control. The developer is required to live up to the representations made. If the Klamath plant fails to achieve the estimated efficiency or cogeneration goal and the actual emissions are greater than the projections, the developer is required to compensate through new offsets. The council did not require guarantees for off-site projects.

Competitions reduce the time for siting power plants, but setting a standard is preferable

The competition was a unique situation that fit the circumstances at the time. Under the usual siting process, the Energy Facility Siting Council can negotiate with the developer if the proposal fails to meet the standards and suggest amendments so that it complies. A developer who does not accept the amendments can withdraw. With a competition, however, no amendments or modifications were allowed. "Because it was a competition," says Sam Sadler, an energy analyst with the Oregon Office of Energy, "the council had to take a hard line and make them stick to what was first proposed."

Proposals can be reviewed fairly

In addition to encouraging a diversity of proposals, the competition showed that it is possible to apply

The offsets from the Klamath plant are equivalent to taking 2.6 million cars off the road.

consistent evaluation standards for reviewing diverse projects. In quantifying offsets, for example, the council established conventions such as considering all three plants as operating at 100 percent capacity for a 30-year life.

Carbon dioxide offsets are financially viable

All three developers who participated are independent power producers who must produce energy at a competitive rate in order to sell it in the marketplace to utilities or large industrial customers. The fact that the independent power producers were willing to offer offsets showed that it is feasible to address global climate change and still remain competitive.

The Task Force

The Energy Facility Siting Task Force created by the governor and legislature was charged with reviewing the process of siting power plants. The task force included seven members with diverse perspectives. Among them were a state senator and professor of political science, who was appointed by the president of the Senate; a state representative and businessman, appointed by the speaker of the House; a professor of economics and former Public Utility Commission chairman; an eastern

Oregon county planning director; a labor union official and former state representative; a state environmental policy coordinator and former law school professor currently assigned to a federal natural resource agency; and a business council president and former state official—the last five appointed by the governor.

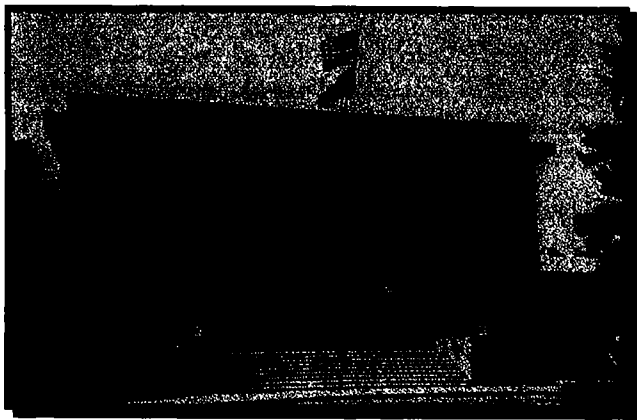
In the task force's final report, the chairman, Mike Katz, wrote: "The issues considered by the task force are contentious, to put it mildly. Parties at interest include utilities, environmentalists, power plant developers, consumer representatives, the Oregon Office of Energy, and the Energy Facility Siting Council." He concluded, "Here is something notable: the task force's recommendations are unanimous."



Architect's rendering of proposed Klamath Falls power plant, which will be built in 1997-1999.

In a landmark decision, the task force called for a law requiring all new power plants to offset their carbon dioxide emissions. The task force's recommendation was incorporated in the law passed in 1997 to revise the siting standards for energy facilities. The law mandates that natural gas-fired generating facilities intended for base-load use achieve a reduction of 17 percent below the emissions of the most efficient, combined cycle, combustion turbine, gas-fired plant commercially operating in the United States. Utilities, developers, environmentalists, and state energy agencies all supported the law.

The task force, in a quid pro quo with power plant



Klamath Falls City Hall uses geothermal district heating.

developers, also recommended jettisoning the need for power standard, having concluded that it is outdated. Developers today choose to build plants that burn natural gas and are less polluting and cheaper than large-scale nuclear and coal-fired plants. The task force decided that these market forces rather than consideration of cost-effectiveness should determine the need for new power plants.

Additional Global Warming Activities

Oregon started in 1988 laying the foundation for these historic decisions. First, the state inventoried its carbon dioxide emissions and analyzed the potential impacts of global warming on Oregon. Next, the state received financial and technical support from the U.S. Environmental Protection Agency's State and Local Climate Change Program for an updated inventory of emissions and an action plan of cost-effective strategies. Oregon's latest plan was completed in 1995.

The state laid the groundwork through these studies, and then citizens' panels took action. In 1992, the Oregon Progress Board adopted a benchmark requiring that the state's emissions be held to 1990 levels. Then in 1995 and 1996, the Oregon Energy Facility Siting Task Force and the Oregon Energy Facility Siting Council—both citizens' panels—provided the leadership that set the carbon dioxide standard and conducted the competition that inspired the innovative Klamath project.

As the task force report states, Oregon has sent a signal to the nation that the state "is prepared to do its fair share" to address global climate change.

For More Information

To review the text of the legislation that revises Oregon's energy facility siting standards (HB 3283, A-Engrossed), see the Oregon legislature's website at

<http://www.leg.state.or.us/search1.html>

Search site for "3283"

To review the order for the competition and the Oregon Energy Facility Siting Task Force's final report, see the Oregon Office of Energy's website at

<http://www.cbs.state.or.us/external/ooel/nucsafel/report.htm>

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Washington, DC 20460

Phone: 202-260-3354 Fax: 202-260-0290

Internet: <http://www.epa.gov/globalwarming/actions/state>





Climate Change Mitigation in Oregon

Oregon's Greenhouse Gas Emissions (1990)¹

- Total greenhouse gas emissions in 1990 were about 15 million metric tons of carbon-equivalent, about 1% of the U.S. total for that year.
- Per capita emissions for 1990 were about 5.4 metric tons, lower than the 1990 national average of 5.8.
- The major source of greenhouse gas emissions in was transportation, which accounted for about 35% of all emissions.
- The second highest source of greenhouse gas emissions in Oregon was electric utilities products, accounting for 29% of emissions, followed by natural gas, which accounted for about 9% of total emissions.

Mitigation Policy Planning:

- In 1995, the Oregon Department of Energy completed *The Report on Reducing Oregon's Greenhouse Gas Emissions*. The report identified a list of options that would reduce 84% (about 3.7 out of 4.4 MMTCE) of the emissions required to restore 1990 levels by 2015. The box below lists the policies recommended the report²

Policies Recommended in Oregon:

Residential:

- Extend residential tax credit
- Continue to fund the Home Oil Weatherization Program
- Standards for homes and appliances
- Provide technical assistance to consumers about saving energy
- Support pricing strategies and environmental costing policies (send signal to consumers)

Industrial & commercial:

- Codes and Standards for appliances
- Training for building operators (to improve operating efficiency)
- Demonstration projects for new energy saving technologies

Transportation:

- Oregon Transportation Plan: construct more bike lanes and walkways, reduce transportation use 20% by 2000 for state agencies, implement telecommuting (linked with Business Energy Tax Credit program)
- Develop an integrated management system to ensure intermodal compatibility
- Educational programs about ways to save fuel
- Study potential for using market incentives to encourage purchase of efficient trucks and cars

Electricity generation:

- Require utilities to consider CO₂ emissions in their integrated resource plans
- Energy efficiency and renewable resource programs

Forestry:

- Tree planting programs (Oregon Forest Resources Trust)

Municipal (Recycling and Solid waste management):

- Implement Integrated Resource and Solid Waste Management Plan (goal: 50% recovery rate using Business Energy Tax Credit as incentive)

Sample of existing Oregon policies that reduce greenhouse gas emissions³:

- CO₂ standard requiring new utilities to emit 17% less than most energy efficient plant available. Energy facilities may meet the standard by paying a per-ton of CO₂ offset equal to \$0.57 per ton initially. A non-profit group for CO₂ mitigation efforts will use the revenue generated.

² Source: Ibid.

³ Sources: *National Conference of State Legislatures Energy Newsletter*, Vol.4, Number 3, Winter 1997;
The Green Power Network, U.S. Department of Energy EREN, www.eren.doe.gov/greenpower, October 5, 1998;
State Renewable Energy News, Volume 6, No.1, Winter 1997, NARUC Subcommittee on Renewable Energy;
Green Power Newsletter, Number 6, March 1998, The Regulatory Assistance Project, www.rapmaine.org;
Colorado Wind Power Buyers, Land and Water Fund of the Rockies, September 1998;
Colorado Solar Energy Industries Association, www.coseia.org/rebate.html, August 1998;
Renewable Energy Sourcebook: A Primer For Action, Public Citizen, www.citizen.org/CMEP/renewables, June 1998;
Green Power Notes, Center for Energy Efficiency and Renewable Technologies (CEERT), Center for resources Solutions (CRT), and Renewable Energy Marketing Board (REMB), www.cleanpower.org and www.green-e.org, June 1998;
The States and Global Climate Change: Adopted and Proposed Initiatives, Submitted by The Center for Policy Alternatives, prepared by The Harrison Institute for Public Law, 1997;
State and Local Legislative and/or Administrative Actions Having Direct or Incidental Effects on Greenhouse Gas Emissions, Center for Global Change, April 1992;
Database of State Incentives for Renewable Energy, North Carolina Solar Center and Interstate Renewable Energy Council (IREC), www-solar.mck.ncsu.edu, May 1998;
Government Actions on Climate Change in the Metropolitan NY/NJ/CT Region, Regional Plan Association, March 1998;

⁴ *The Source for Renewable Energy*, <http://www.sourceguides.com/energy/businesses>, October 1998.

⁵ *U.S. Communities Acting to Protect the Climate: A Report on the Achievements of ICLEI's Cities for Climate Protection - U.S.*, International Council for Local Environmental Initiatives, November 1997;
EPA Program Managers as of November 1997. For further information, please see www.epa.gov/globalwarming.

 \$248 million will be saved by Massachusetts companies and organizations thanks to investments already made through EPA's ENERGY STAR programs.



MASSACHUSETTS

More ENERGY STAR Facts

- Massachusetts is home to 158 companies and public entities participating in ENERGY STAR partnerships.
- Over 200 million square feet of Massachusetts building space are currently committed to the ENERGY STAR Buildings and Green Lights partnership — an area 265 times the size of the Fleet Center.
- 5 ENERGY STAR-Labeled Product manufacturers are located in Massachusetts.
- Investments already made through the ENERGY STAR program in Massachusetts will prevent over 6 billion pounds of carbon dioxide (CO₂). This reduction in CO₂ emissions is equivalent to planting 927,000 acres of trees — an area 660 times the size of the University of Massachusetts-Amherst.
- Nitrogen oxide (NO_x) emissions will be reduced by over 11 million pounds and sulfur dioxide (SO₂) by 33 million pounds due to existing ENERGY STAR investments in Massachusetts.

Highlights

- Polaroid received the ENERGY STAR Buildings Corporate Partner of the Year Award in 1999.
- Staples received the Green Lights Retail Partner of the Year Award in 1999.
- Massachusetts Institute of Technology received the Green Lights University Partner of the Year Award in 1996.
- Major Massachusetts buildings including the Lafayette Corporate Center in Boston have expressed their commitment to being among the top 25 percent in energy performance nationally.

Market Potential

- Massachusetts has 1.8 billion square feet of ENERGY STAR Buildings-upgradable floor space and an enormous potential for further using ENERGY STAR products. If all available opportunities for profitable energy efficiency improvements were taken advantage of,
 - More than \$708 million would be saved annually
 - The following emissions would be prevented each year:
 - 15 billion pounds of CO₂
 - 26 million pounds of NO_x
 - 76 million pounds of SO₂

ENERGY STAR Participants in Massachusetts

A 1 Lighting Service Company
 Abercrombies Farmington Inn
 Aetna Corporation
 Allen House Victorian Inn
 Almeida Electrical, Inc.
 Alternative Resource Management Services
 American Cancer Society
 American Energy Control of Boston, Inc.
 Andover Inn
 Applied Energy Services, Inc.
 Ashley Inn
 Association of Industries of Massachusetts
 Avon Inn
 BJ's Wholesale Club, Inc.
 Bob Sacari Electric
 Babson College
 Barbizon
 Beach Tree Inn
 Bed & Breakfast Inn
 Bentley College
 Beth Israel Deaconess Medical Center
 Black Fox Designs, Ltd.
 Boston Edison Company
 The City of Boston, Massachusetts
 Brandeis University
 Brandit House Bed & Breakfast
 Brew Moon Inc.
 Browne's Garage
 Carby's Inc.
 City of Cambridge, Massachusetts
 Camp Dresser & McKee, Inc.
 Cape Cod Chamber of Commerce
 Cape Cod Claddagh Inn
 Captain Ezra Nye House
 Captian House Inn
 Centre Street Inn
 Chemi-Graphic Inc.
 Chicopee Public School District
 Committee on Faith & The Environment
 Commonwealth Electric Company
 Concord Municipal Light Plant
 Coneco Corporation
 Cowgirl In The Sand
 Cranberry Inn at Chatham
 The Crestview Plaza
 Dandelions And Designs
 Dark to Light, Inc.
 Data General Corporation
 Deerfield Inn
 Demand Management Institute
 Digital Equipment Corporation
 Dudley Street Neighborhood Initiative
 E.C. Hillard Corp
 ESCO Energy Services Company

EUA Cogenex Corporation
 Eagle Electric Supply Company, Inc.
 Eastern Bank Corporation
 Ebenezers Place
 Encon Systems Incorporated, Hopkinton
 EnerCon, Inc.
 Energy Capital Partners/MA
 Energy Federation Incorporated
 Energy USA
 Episcopal Diocese of Massachusetts
 Fifty Washington Limited
 Foxboro Company
 Fred Davis Corporation
 Garden Club Federation of Massachusetts
 The Gillette Company
 Global Recycling Technologies
 HEC, Inc.
 Hallmark Health
 Hampshire College Pugwash
 The Harvard Crimson
 Harvard Medical School
 Holyoke Community College
 Independent Electric Supply Co.
 Jaes Café
 Joan Fabrics Corporation
 John F. Kennedy School of Government at Harvard U.
 Joseph V. Arno
 Juniper Russell, Michael Andelman and Associates
 K-V Associates Inc
 Lesley College
 Litecontrol Corporation
 Litemor Distributors of Boston Ltd.
 Malden Mills
 Maple Terrace Motel
 Marvel Lighting Corporation
 Massachusetts Institute of Technology
 Massachusetts Maritime Academy
 Massachusetts Municipal Wholesale Electric
 The Commonwealth of Massachusetts
 Medical Area Total Energy Plant Inc of Harvard University
 Meineke Shop 138
 Millipore Corporation
 Mitre Corporation
 NEES Companies
 Natick Village Condominiums Association
 National Association of Power Engineers
 Northampton, City of
 Northeast Energy Efficiency Council
 Northeast Public Power Association
 Northeastern University
 Norwood Municipal Light Department

Nuestra Comunidad Development Corp.
 OSRAM Sylvania, Inc.
 Old Colony Electrical Company, Inc.
 The Old North Church
 Olde Captains Inn
 Onset Pointe Inn
 Pacific Scientific, Fisher Pierce Division
 Packard Bell/NEC CSD
 Pequod Associates
 Polaroid Corp.
 Printing Industries Of New England
 R.G. Vanderweil Engineers
 Reebok International Limited
 Responsible Energy of Hampshire College
 Rexam
 Richard E. Wolfert, MD
 Roman Catholic Archbishop of Boston
 St. Mark's School
 Salesco Systems USA
 Screen Prints of Hyannis
 Shaker Workshop
 Shaw's Supermarkets, Inc.
 Smaller Business Association of New England
 Smith College
 Solium, Inc.
 Special Events Catering
 Spir-it, Incorporated
 Springfield College
 Staples, Inc.
 Stillpoint Bed & Breakfast
 Stocker & Yale
 Strategic Energy Partners
 Students for an Energy-Efficient Environment
 Synergy Investment Incorporated
 Taunton Municipal Lighting Plant
 Tecken, Inc.
 The Woodenfolk
 Trainco Heatmaker Incorporated
 Tufts University
 UDEC/TLS Mfg., Inc.
 Massachusetts Army National Guard
 Westover Air Reserve Base
 Unifirst Corp.
 Union of Concerned Scientists
 Urban Solar Buildings Initiative
 Utility Bill Consultants
 Warehouse Club Focus
 Waters Corporation
 Williams Inn
 Work Stations, Inc.
 Wysocki & Associates
 Xenergy
 ZYZYK

Examples of Massachusetts Partners Saving Money and Helping the Environment

Staples, Framingham

"For us, it's all about delivering on our commitment to provide customers with maximum temperature, lighting, and air quality comfort during their shopping experience at Staples. By doing this in the most energy efficient way, we've been able to pass the reduced operating costs onto those customers in the form of lower prices."

— Bob Valair, Staples

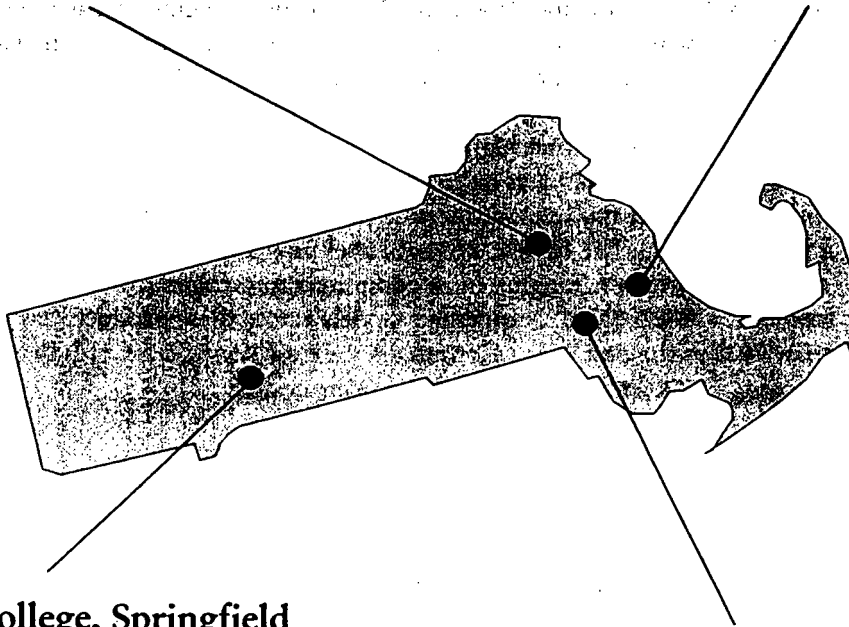
- Saving \$985,000 in annual energy costs and 6.5% off of every utility bill
- Upgraded lighting in over 10 million sq. ft., in 100 percent of stores
- Reducing energy use by 6.3 million kWh annually
- Preventing 6.4 million pounds of CO₂ annually
- Incorporating energy efficiency features into its HVAC systems, LED exit signs, and building envelope

Shaw's Supermarkets, East Bridgewater

"Over the years, we've learned that it's much more cost effective to design an energy efficient store up front than to retrofit ... Today, we don't rest. We're always looking for new equipment and technology that will enable us to enhance our energy efficiency."

— Kathy Loftus, Shaw's Supermarkets

- Saving \$107,000 in annual lighting costs
- Saving \$25,000 to \$30,000 per store in total annual energy costs
- Upgraded lighting in 75 percent of stores
- Preventing 2.4 million pounds of CO₂ annually
- Incorporating energy efficiency technologies including T8 lamps, LED exit signs, energy management systems, and variable speed drives into newer stores



Springfield College, Springfield

- Saving \$162,780 in annual energy costs
- Upgraded lighting in 1 million sq. ft.
- Reducing energy use by 1.5 million kWh annually
- Preventing 2.5 million pounds of CO₂ annually

Foxboro Company, Foxboro

- Saving \$626,000 in annual energy costs
- Investment in lighting upgrades has yielded a 79% rate of return on completed projects
- Preventing 4.2 million pounds of CO₂ annually

EPA's ENERGY STAR Programs

ENERGY STAR Buildings and Green Lights Partnership



ENERGY STAR Buildings and Green Lights is a voluntary partnership between U.S. organizations and the U.S. Environmental Protection Agency to promote energy efficiency in commercial buildings. U.S. organizations can save over \$130 billion by 2010 by becoming more energy efficient. To reach this potential, the Partnership focuses on reducing energy use and improving building performance through the use of strategic energy management and more efficient technologies. EPA provides the participants with technical information, customized support services and other resources. EPA also provides the ability to benchmark individual buildings, and distinguish those buildings that demonstrate superior performance. Investments already made through ENERGY STAR Buildings will save participants over \$3.5 billion and prevent 78 billion pounds of CO₂ from being released into the atmosphere. The program currently has over 3000 participants, representing close to one out of every seven commercial square feet in America.

ENERGY STAR Products



The U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) are working together to help consumers choose energy-efficient equipment for their homes and offices by awarding the ENERGY STAR Label to efficient, high-quality products. These products save money because they use much less energy. For those with somewhat higher costs up front, the cost is quickly offset by energy bill savings. Manufacturers or retailers volunteer to place the ENERGY STAR Label on those product models that meet or exceed energy and performance criteria set by EPA and DOE. The ENERGY STAR Label now appears on more than 26 energy consuming products ranging from computers to refrigerators to televisions. The number of ENERGY STAR qualified models across these products has grown to more than 3400 in the past year. Consumers are now saving over \$1 billion a year by bringing ENERGY STAR products into their homes.

ENERGY STAR Homes



The ENERGY STAR Homes Program promotes voluntary partnerships with builders to construct residences that are at least 30 percent more energy efficient than the current Model Energy Code. The Program provides approved builders with a brand name label and preferred mortgage financing. ENERGY STAR homes include such features as advanced insulation, tight construction, advanced duct sealing, high-performance windows, and high-efficiency heating and cooling systems and appliances. They cost less than ordinary homes because energy savings typically exceed the small increase in monthly mortgage costs from the improved energy features. The Program saves thousands of dollars over the life of a mortgage, increases the resale value of a home and reduces air pollution. The ENERGY STAR Homes Program currently includes over 1500 organizations and 6600 homes.



Climate Change And Massachusetts

The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is *enhanced* by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

Emissions Of Greenhouse Gases

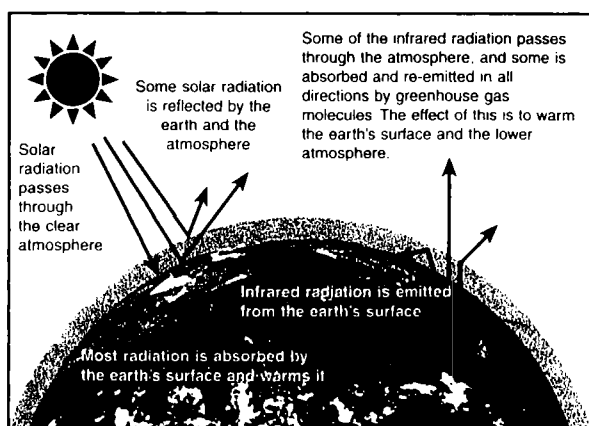
Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, common air pollutants, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally.

Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

The Greenhouse Effect



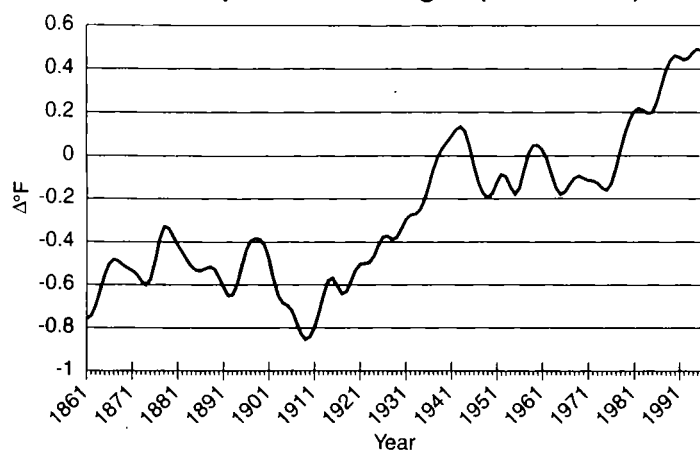
Source: U.S. Department of State (1992)

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen 4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that *“the balance of evidence suggests a discernible human influence on global climate.”*

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. Scientists are reasonably confident about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6–6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6–38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems

(droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in Amherst, Massachusetts, has increased 2°F, and precipitation has increased by up to 20% in many parts of the state.

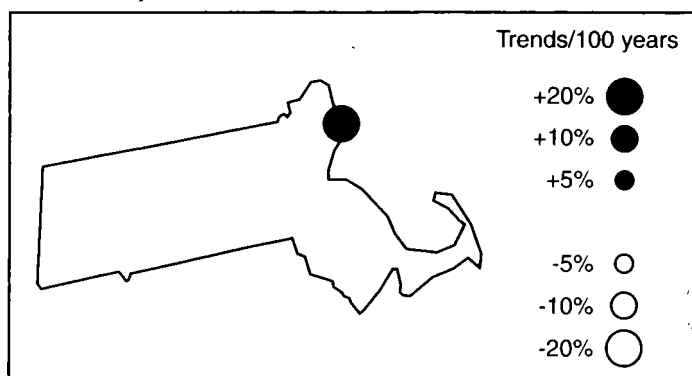
Over the next century, climate in Massachusetts may change even more. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre’s climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in Massachusetts could increase by about 4°F (with a range of 1–8°F) in winter and spring and about 5°F (with a range of 2–10°F) in summer and fall. Precipitation is estimated to increase by about 10% in spring and summer, 15% in fall, and 20–60% in winter. Other climate models may show different results. The amount of precipitation on extreme wet or snowy days in winter is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. Although it is not clear how severe storms such as hurricanes would change, an increase in the frequency and intensity of winter storms is possible.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Massachusetts, with its irregular, intense heat waves, could be especially susceptible.

In Boston, one study projects that by 2050 heat-related deaths during a typical summer could increase 50%, from close to 100 heat-related deaths per summer to over 150 (although increased air conditioning use may not have been fully accounted for). Winter-related deaths are expected to change very little. The elderly, particularly those living alone, are at greatest risk.

Climate change could increase concentrations of ground-level ozone. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Air pollution also is made worse by increases in natural hydrocarbon emissions during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

A 4°F warming in New York City, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by 4%. Similar increases could occur in Massachusetts. Currently, ground-level ozone concentrations exceed national ozone health standards throughout the state. All of Massachusetts is classified as a "serious" nonattainment area for ozone. Ground-level ozone has been shown to aggravate respiratory illnesses such as asthma, reduce existing lung function, and induce respiratory inflammation. In addition, ambient ozone reduces crop yields and impairs ecosystem health.

Warming and other climate changes may expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitos flourish in some areas around Massachusetts. Some can carry malaria, while others can carry Eastern equine encephalitis, which can be lethal or cause neurological damage. Incidents of Lyme disease, which is carried by ticks, have increased in the Northeast. If conditions become warmer and wetter, mosquito and tick populations could increase, thereby increasing the risk of transmission of these diseases.

In addition, warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. These blooms damage habitat and shellfish nurseries, can be toxic to humans, and can carry bacteria like those causing cholera. Brown algal tides and toxic algal blooms already are prevalent in the Atlantic. Warmer ocean waters could increase their occurrence and persistence.

Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

The coast of Massachusetts is an important resource with over 1,500 miles of shoreline. Massachusetts' coastline includes stretches of rocky shore, barrier beaches, productive estuaries, fragile salt marshes, tidal flats, and dozens of islands. Barrier beaches, salt marshes, and other wetland resource areas buffer the coast from storms, waves, and flooding.

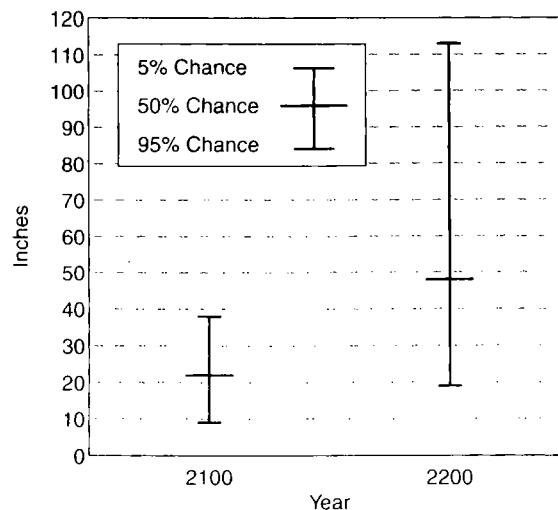
At Boston, sea level already is rising by 11 inches per century, and it is likely to rise another 22 inches by 2100. Rising sea levels are taking a toll on Massachusetts' coastal upland. Each year, an average of 65 acres of upland is submerged by a combination of rising seas and subsiding land. Much of this loss occurs along the south-facing coast between Rhode Island and the outer shore of Cape Cod, including the islands of Nantucket and Martha's Vineyard. Coastal land that has been lost because of erosion by storm waves or wetland erosion is not included in the estimate of annual average land lost from submersion.

Possible responses to sea level rise include building walls to hold back the sea, allowing the sea to advance and adapting to it, and raising the land (e.g., by replenishing beach sand, elevating houses and infrastructure). Each of these responses will be costly, either in out-of-pocket costs or in lost land and structures. For example, the cumulative cost of sand replenishment to protect the coast of Massachusetts from a 20-inch sea level rise by 2100 is estimated at \$490 million to \$2.6 billion.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. If streamflow and lake levels drop, groundwater also could be reduced. In addition, more intense precipitation could increase flooding.

**Future Sea Level Rise
At Woods Hole, Cape Cod**



Source: EPA (1995)

eastern parts of the state drain directly to the Atlantic Ocean. Relatively little of the flow of the Connecticut River originates in Massachusetts, but it is the source of much of the water supply for the Boston metropolitan area. The flow of the Connecticut is strongly affected by winter snow accumulation and runoff from Vermont and New Hampshire. A warmer climate would lead to earlier spring snowmelt, resulting in higher streamflows in winter and spring and lower streamflows in summer and fall. However, warmer summer temperatures could increase water quality problems because of increased evaporation (which concentrates pollutant levels) and more favorable conditions for algae and other water organisms. Increased rainfall could mitigate these effects, but it also could contribute to localized flooding.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

In Massachusetts, agriculture is a \$500 million annual industry, three-fourths of which comes from crops. Very little of the crop acreage is irrigated. The major crops in the state are silage, hay, and potatoes. Climate change could change crop yields little or

farm and production. For example, potato yields could decrease while production rises because of an increase in potato acres farmed.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic range, and health and productivity. If conditions also become drier, the current range of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to warmer conditions, such as oaks and pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

Although the extent of forested areas in Massachusetts could change little because of climate change, a warmer climate could change the character of those forests. Maple-dominated hardwood forests could give way to forests dominated by oaks and conifers, species more tolerant of higher temperatures. This change would diminish the brilliant autumn foliage as the number of maple trees declines. Across the state, as much as 30-60% of the hardwood forests could be replaced by warmer climate forests with a mix of pines and hardwoods.

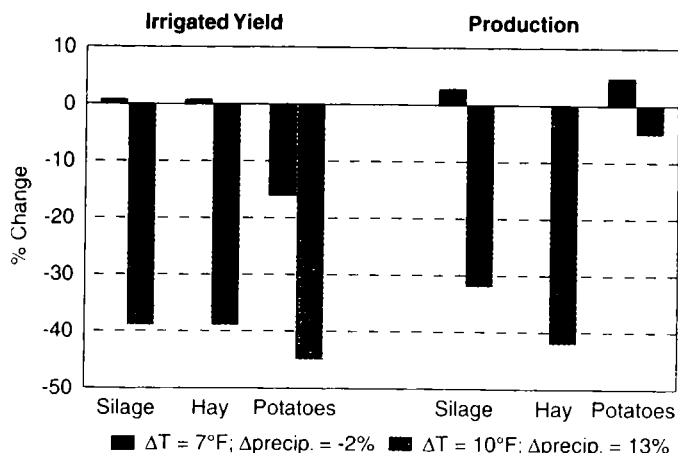
Ecosystems

The coastal beaches and tidal marshes of Massachusetts are especially sensitive to the effects of sea level rise and changes in river flows. Sea level rise could inundate coastal wetlands, destroying habitat for commercial and game species as well as migratory birds and other wildlife. Barrier beach island refuges such as the Monomoy National Wildlife Refuge south of Cape Cod and the Parker River National Wildlife Refuge in northeastern Massachusetts could be threatened or lost. These refuges provide important habitat for migratory birds, including the threatened piping plover and the endangered roseate tern. Harbor and gray seals, which use beaches as refuge in the winter, also could lose habitat if sea levels rise.

Forests and woodlands support much of the wildlife in the state. Climate change could result in changes in these ecosystems. Fragmented land use patterns could impede migration of some plant species, resulting in loss of some native plants and increases in non-native plants. Changes in rainfall and runoff could change sediment levels in streams and wetlands, thus affecting fish and aquatic habitats.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

