Union of Concerned Scientists

Catalyst

SUMMER 2011

Can It Happen Here?

Yes—if we let it.
Fukushima's lessons for the United States

Also: Mapping Climate Change • Concentrating Solar Power

Union of Concerned Scientists

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LETTERS

Please email your questions or comments to catalyst@ucsusa.org. *Your submission implies permission to publish your letter and name in* Catalyst. *We reserve the right to edit letters for length.*

Bring Back Meatless Tuesdays?

Your insightful article, "Building a Better Burger" (Spring 2011, p. 10), points out how raising beef cattle contributes significantly to climate change. I wonder why you don't advocate that people consider shifting toward plant-based diets by at least giving up eating meat one day a week.

In addition to reducing greenhouse gas emissions, such a change would improve human health; reduce deforestation, soil erosion, desertification, water pollution, rapid species losses, and other environmental problems; use water, energy, and other resources more efficiently; and, of course, reduce the mistreatment of animals.

Richard H. Schwartz, Ph.D.
Staten Island, NY

The author responds:

We agree that reducing or eliminating our consumption of meat can have a significant positive impact on the environment, but we also recognize that not everyone will shift to a wholly plant-based diet regardless of its many benefits. It is therefore important to educate policy makers, farmers, and meat eaters about the choices they can make to support more sustainable animal agriculture.

UCS advocates for solutions that emphasize both conservation (e.g., eating less meat) and better purchasing choices (e.g., choosing pasture-raised and antibiotic-free meat). These complementary approaches could have a significant impact if more people adopted them and better policies supported them.

Doug Gurian-Sherman, senior scientist
UCS Food and Environment Program

Fuel-Efficient Cars of Yesteryear

Jim Kliesch refers to "new vehicles that can go 40 miles per gallon [mpg] of gas on the highway using conventional technology, and for a reasonable price—an achievement that automakers dismissed as implausible only a few years ago" ["On the Road," Spring 2011, p. 13].

How can they dismiss as implausible something that has already been done? My 1991 Pontiac Firefly convertible still gets 45 mpg on regular gas. [It] cost less than $11,000. If they could make them then, why can't they make them now?

David H. Owens
Ann Arbor, MI

The author responds:

Today's cars and trucks are safer and produce significantly less smog-forming emissions than in the past (thanks in large part to state and federal regulations), but automakers have not made similar progress on fuel economy and global warming pollution. Instead they opted to use technology to make vehicles bigger and faster.

Industry lobbying kept fuel economy standards from being substantially improved for nearly two decades, starting in the late 1980s. Now that stronger standards are finally set to begin taking effect next year, we will see more smart engineering in engines, transmissions, aerodynamic improvements, and high-strength lightweight materials that help reduce our oil dependence and save us money at the pump.

Jim Kliesch, research director
UCS Clean Vehicles Program

Back issues of *Catalyst* are available in PDF form on the UCS website at *www.ucsusa.org/publications/catalyst.*

Photo: © Comstock

PERSPECTIVE

Science Should Be a Bipartisan Issue

Climate denial is in fashion among members of Congress who, like Representative Dana Rohrabacher (R-CA), continue to ignore the facts. Rohrabacher uses his website to praise his district's "scientific and research companies," and "institutions of higher education." Yet, he also puts out scientifically erroneous information—that temperatures have not risen nationally since 1998 or that global warming could be caused by sunspots—in order to justify inaction on climate change today. Meanwhile, officials in Rohrabacher's own district are concerned enough about global warming to adopt a sustainability plan for the city of Long Beach, and to study the effects of rising sea levels on the city's freshwater supplies.

Attacks on science may score political points with partisan supporters, but could also have serious consequences that extend far beyond the ballot box.

History has shown that science is often used as a political football. In 1920 Albert Einstein wrote, "Currently, every coachman and every waiter is debating whether relativity theory is correct. Belief in this matter depends on political party affiliation." Rohrabacher's attacks on science may score political points with his partisan supporters—as other climate deniers in Congress are attempting to do by stripping the Environmental Protection Agency of its authority to regulate global warming emissions, or by cutting funding for programs that protect public health and the environment—but this posturing could also have serious consequences that extend far beyond the ballot box.

Fortunately, history also provides us with a blueprint for how to thwart science deniers. When the tobacco industry tried to mislead people about the dangers of smoking, health professionals countered the industry's misinformation with effective communication based on solid science, translating the facts about smoking's impact on human health into terms that helped people see how cigarettes could destroy their lives.

In a similar vein, UCS is working with professionals who, like scientists, are trusted by the public and can communicate the facts on global warming in a way that clearly illustrates its potential impact on our daily lives. Doctors are helping us describe the health threats of climate change, economists are adding up the future savings—and costs of inaction—associated with climate policies, and military officials are stressing their conclusion that climate change could threaten national security. By collaborating with these experts and engaging Americans across political lines, we hope to transcend partisan divides and turn our decision makers from the wrong side of science to the right side of history.

—***Kevin Knobloch***, *president*

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DEPARTMENTS

UCS Illustrates the Power of Wind

Jobs and tax revenue are just two of the benefits

To help counter misleading statements made by the fossil fuel industry and its supporters about renewable energy, UCS has launched "Renewables: Energy You Can Count On," a series of short reports that explore the benefits and challenges associated with bringing more clean, homegrown electricity to the grid.

The first installment, *Tapping Into Wind Power*, shows that wind is one of the most cost-effective sources of electricity available, competitive with power from new natural gas plants and cheaper than power from new coal and nuclear plants. Growing interest in wind helped the industry weather the recent recession, creating 50,000 full-time jobs between 2007 and 2009. Wind projects also benefit local communities financially, as governments and land owners can earn revenue from property and income taxes and other payments made by project owners.

Future installments in the series will explore the economic benefits of clean energy policies, land-use comparisons between renewable and conventional power facilities, and electrical grid reliability. You can read *Tapping Into Wind Power* on the UCS website at *www.ucsusa.org/tappingintowind*.

Building a Chorus for Change

UCS helps young scientists find their voice

In late March, science policy groups at both Harvard and MIT invited UCS to conduct workshops that would help graduate students become strong advocates for science-based policies. About 30 students from the Harvard Science Policy Group attended our "Speaking Out and Speaking Up" workshop led by Dr. James McCarthy, chair of the UCS board of directors and the Alexander Agassiz Professor of Biological Oceanography at Harvard, who, along with other UCS staff, discussed how scientists can communicate effectively with elected officials.

Our second workshop prepared students in the MIT Science Policy Initiative for their upcoming trip to Washington, DC, to lobby Congress to fully fund scientific research initiatives.

These workshops demonstrated the energy, passion, and determination many of today's graduates have to improve their world.

UCS staff discussed the culture of Capitol Hill, provided tips and tools on how to communicate science effectively, and led breakout sessions in which the students practiced talking about their research. These events demonstrated the energy, passion, and determination many of today's graduates have to improve their world. UCS is eager to help ensure their expertise informs the challenges we face.

The Power Sector's Water Addiction

UCS shows how it hurts consumers* and *the industry

Because power plants account for more than 40 percent of freshwater withdrawals in the United States, rising demand for electricity will put water resources, the electricity sector, and other water users at growing risk. *Power and Water at Risk*, the latest in our series of fact sheets about the "energy-water collision," shows examples where these problems are already occurring and how we can address them, especially in the face of global warming.

Photo: © IndexOpen

Drought and high water temperatures caused by heat waves force fossil fuel and nuclear power plants that rely on water for cooling to cut production or even shut down. Conversely, supplying water to such plants in times of water stress or scarcity can come at a cost to others who rely on that water.

Fortunately, some power companies are making improvements to lower their water use, such as "dry-cooled" plant designs (see "How It Works," p. 13). Elsewhere, energy efficiency and renewable energy resources such as wind and solar are addressing water and climate challenges simultaneously. To learn more about energy-water collisions and solutions around the country, visit *www.ucsusa.org/power-water-risk*.

Rising demand for electricity will put water resources, the electricity sector, and other water users at growing risk.

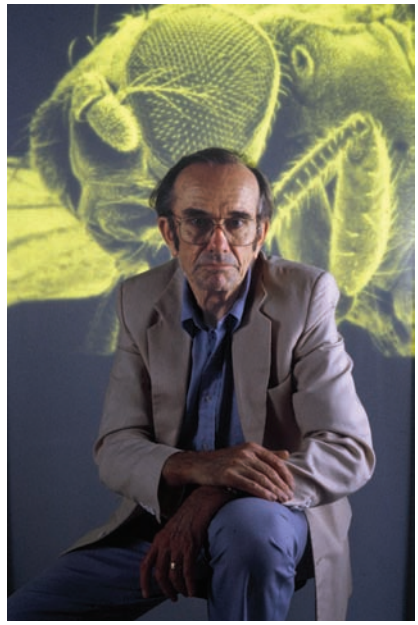
In Memoriam

Thomas Eisner (1929–2011)

We mourn the passing of Thomas Eisner, a seminal figure in the field of chemical ecology and a UCS board member since 1993. The Jacob Gould Schurman professor emeritus of Chemical Ecology at Cornell University and director of the Cornell Institute for Research in Chemical Ecology died on March 25 at the age of 81.

After fleeing from Germany to Uruguay at the start of World War II, Tom became fascinated with bugs and their behavior—particularly how insects use chemistry to protect themselves, procreate, and defend their kin. He turned this interest into a lifelong career, earning both a bachelor's and doctoral degree in biology at Harvard, then serving on the faculty at Cornell for more than 50 years.

Tom's research revolutionized the understanding of the role of basic chemistry in the life of higher organisms and gave birth to the field of chemical ecology. Among his research subjects were bombardier beetles, which spray a jet of boiling hot, caustic liquid at predators; ornatrix moths, which carry a noxious chemical that persuades spiders to set the moths free when they become trapped in a web; and palmetto beetles, which produce an oily liquid that helps them cling to leaves.



Tom recognized the potential for plants and insects to contain chemicals important to human medicine, and worked to preserve wildlife habitats so species could thrive. His guidance led UCS to establish biodiversity conservation and defense of the Endangered Species Act as organizational priorities, and he was one of the first scientists to sign a 2004 UCS letter calling on the government to restore scientific integrity to federal decision making. This letter galvanized the scientific community's opposition to political interference in science, and planted the seed for our Scientific Integrity Program.

On top of his academic achievements—which earned him the National Medal of Science in 1994, the highest scientific honor in the United States—Tom was a renowned nature photographer, talented classical pianist, and prize-winning author and filmmaker. His 2003 book, *For Love of Insects*, was named Best Science Book in 2004 by the Independent Publisher Book Awards.

UCS President Kevin Knobloch stated, "Tom's keen intellect, passion for science, and strong leadership helped shape UCS. His contributions to our organization, not to mention the scientific community writ large, will not be forgotten."

Photo: © Cornell University Photography

A Grassroots Campaign—Literally

Gardeners help UCS reform agriculture policy

This spring, UCS traveled to Michigan to help home gardeners learn how they can support climate-friendly growing practices at home and on our nation's farms. At the Michigan Home and Garden Show in Pontiac, we handed out our report *The Climate-Friendly Gardener* and talked with hundreds of attendees about practical steps they can take—such as minimizing pesticide use, composting, and planting winter cover crops—to build healthy soil and reduce their contribution to global warming. Our recommendations are well-suited to the Detroit area's burgeoning urban farming movement, which is transforming vacant lots into gardens that provide fresh produce to inner-city neighborhoods.

The Detroit area's burgeoning urban farming movement is transforming vacant lots into gardens that provide fresh produce to inner-city neighborhoods.

We also asked attendees to create postcards calling on Senator Debbie Stabenow to support climate-friendly farming. As chair of the Senate Agriculture Committee, her leadership is needed to ensure the next federal farm bill promotes the type of diverse, productive, climate-friendly agriculture that will benefit farmers like those of rural Michigan, whose agricultural bounty includes pickling cucumbers, blueberries, and tart cherries, as well as corn and other commodity crops.

UCS Senior Analyst Karen Perry Stillerman discusses sustainable gardening practices with event attendees in Michigan.

Clean Air by the Numbers

UCS tool records lives saved, net benefits

You may already know the Clean Air Act (CAA) has a 40-year track record of protecting human health and the environment. But did you also know it has provided nearly $50 trillion in net benefits as a result? To strengthen support for the CAA, which has been under attack by members of Congress who oppose government regulation, UCS created an animated "ticker" that illustrates the tremendous benefits of the CAA both since it took effect in 1970 and into the future. Most of these benefits are attributable to reductions in premature death associated with particulate matter; looking ahead, cleaner air will prevent an estimated 230,000 premature deaths in 2020 alone.

Since its release in March, the tool has been shared by more than a dozen websites, from blogs (Climate Progress, Treehugger) to advocacy organizations (U.S. Climate Action Network) and government agencies (California Air Resources Board). The EPA also plans to use the ticker at a CAA-related event in June. To see the ticker for yourself, and add it to your own website or social media page, go to *www.ucsusa.org/cleanairticker.*

Since its release, the ticker has been shared by more than a dozen websites, from blogs to advocacy organizations and government agencies.

Photo: Jenn Yates

Can It Happen Here?

Perhaps the better question is, can we *let* it happen? The disaster in Japan has highlighted the problems our nuclear industry has in common with Japan's. UCS is bringing a new sense of urgency to our recommendations for making U.S. nuclear power safer.

On March 11, when a massive earthquake and tsunami damaged Japan's Fukushima Daiichi nuclear power plant, our team of nuclear power experts began examining information coming from Japan to help American journalists, policy makers, and the general public understand that a potentially catastrophic situation was unfolding.

In the weeks that followed, UCS fielded thousands of calls from reporters, held daily press briefings, and continuously updated our website with new information on what was happening in Japan and its implications for nuclear power in this country. One question we have been asked with regularity is, Could it happen here? Based on our nearly 40 years of experience in evaluating nuclear power plant safety, the short answer is yes.

A Recipe for Disaster

The situation in Japan has brought renewed attention to several serious shortcomings in U.S. nuclear power plant safety and oversight that have been evident for years. Each of these flaws, as discussed below, increases the risk of a catastrophic accident.

The situation in Japan has brought renewed attention to several serious shortcomings in U.S. nuclear power plant safety and oversight that have been evident for years.

Insufficient backup power. While only California's reactors are vulnerable to the one-two punch of an earthquake and tsunami, the result at the Fukushima Daiichi plant—a "station blackout," or loss of power from both the electrical grid and backup diesel generators—could similarly occur at U.S. plants in areas subject to earthquakes, hurricanes, tornadoes, or ice storms.

For example, the combination of a tornado and high summer temperatures nearly caused a station blackout at Ohio's Davis-Besse nuclear plant in 1998. After the tornado cut transmission lines linking the plant to the grid, diesel generators provided power for about 26 hours before overheating. Had workers not restored the plant's primary electrical power just before the generators failed, they would have had only four hours of emergency battery backup power to fix the problem before the plant's cooling systems would have stopped and its nuclear fuel begun to overheat. (The Fukushima Daiichi plant had *eight-hour* batteries—better than 90 percent of U.S. reactors—and even that was not enough time to avoid a meltdown there.)

Vulnerable spent fuel pools. Spent fuel rods are still highly radioactive and generate a lot of heat, so they must be cooled

Photo: © AP Photo/Wally Santana

in water-filled pools for at least five years before they can be safely transferred to more permanent storage. When nuclear plants were originally designed, owners assumed their spent fuel would be shipped off-site for disposal. But because the United States has failed to construct a permanent nuclear waste repository, plant owners have packed the spent fuel pools more densely than originally designed and filled them to capacity.

If the flow of cooling water into the pools is interrupted for a prolonged period of time, as it was at the Fukushima plant, the fuel will begin to overheat and melt, just as in a reactor core meltdown. The more fuel in the pool, the faster the water will evaporate and allow the fuel to overheat. With more fuel, there is also more radioactivity that can be released into the environment. And unlike fuel in the reactor core, which is reinforced with steel and concrete, fuel in spent fuel pools is often protected from the elements (and possible attack) only by "sheet metal siding like that in a Sears storage shed," says UCS Nuclear Safety Project Director David Lochbaum. This was the case at the Fukushima Daiichi plant.

Shortsighted evacuation planning. On March 12, the day after the earthquake and tsunami, the Japanese government evacuated more than 75,000 residents within a 12-mile radius of the Fukushima Daiichi plant, and told another 136,000 living 12 to 18 miles away to stay in their homes. It was not until April 22 when the government advised residents in five towns and villages outside the initial evacuation zone to leave. The U.S. government instructed its citizens to stay at least *50 miles* away from the plant.

The U.S. Nuclear Regulatory Commission's (NRC's) emergency preparedness plan for nuclear accidents, as explained by Chairman Gregory Jaczko on March 31, is to evacuate people living within 10 miles of a stricken plant and to monitor food supply contamination within 50 miles. The agency would expand these zones if necessary, but UCS Senior Scientist Edwin Lyman questions the wisdom of this approach: "The notion that you could spontaneously expand an evacuation zone in some of the more densely populated areas of the country and expect that that could be carried out efficiently really strains credulity."

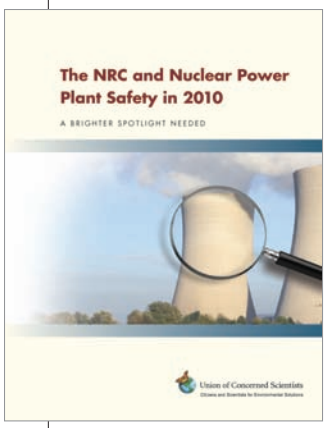
Making Nuclear Power Plants Safer

While UCS research has shown that other clean energy resources could meet America's electricity needs more cheaply than building new nuclear power plants (see the sidebar to the right), the current fleet of 104 U.S. reactors will undoubtedly continue to play a role in our electricity system for years to come. It is

It is imperative that the nuclear industry, the NRC, Congress, and the White House give nuclear safety and security the serious attention they deserve.

Nuclear Near-Misses Close to Home

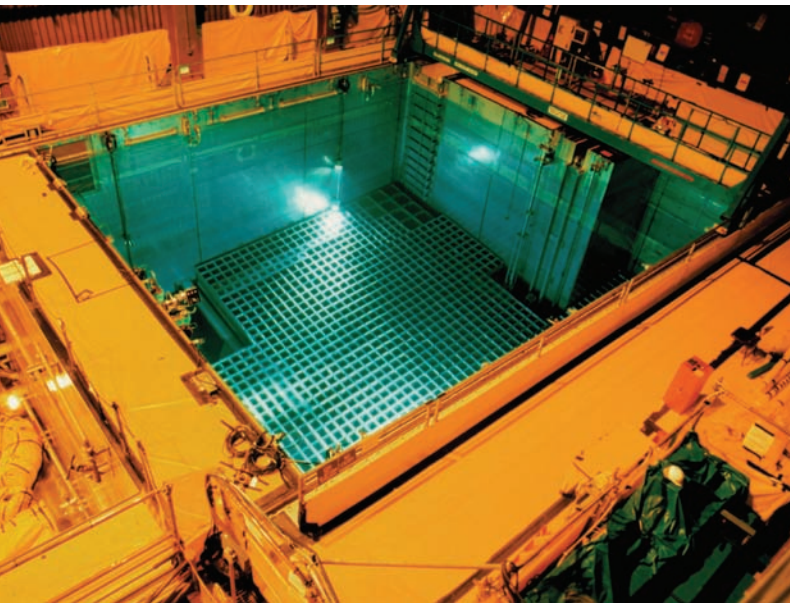
Serious problems at U.S. reactors are happening too frequently for a mature industry.



On March 17, UCS released the first in an annual series of reports assessing the safety of the U.S. nuclear power industry. *The NRC and Nuclear Power Plant Safety in 2010: A Brighter Spotlight Needed* analyzed 14 special inspections the NRC performed last year when equipment problems or security shortcomings increased the chances of a reactor core meltdown by a factor of 10 or more.

Many of these "near-misses" occurred because reactor owners and the NRC tolerated known safety problems. For example, both of the reactors at the Calvert Cliffs plant in Maryland shut down when rainwater leaked in through the roof and dripped onto electrical equipment. As author David Lochbaum explained to reporters, "Workers had noted numerous leaks across many, many months prior to this event, but management always deferred repairs. After all, the roof only leaked when it rained."

The report also highlights instances in which the NRC demonstrated it *can* be an effective regulator, catching safety problems before they could develop into potential disasters. At the Oconee plant in South Carolina, for example, owners fixed a failed safety system component at one reactor but felt confident the other two reactors could not have the same problem; the NRC challenged this argument until the owners tested the other reactors and found the component had failed there as well.



Nuclear plant owners should move spent fuel from overcrowded and unprotected pools (left) to dry casks (right), which are more secure and reduce the risk of overheating.

therefore imperative that the nuclear industry, the NRC (which oversees the industry), Congress (which oversees the NRC), and the White House give safety and security the serious attention they deserve—and have not yet consistently received.

UCS presented the following recommendations (and others) to Congress in the weeks following the Japanese accident:

- **Require plant owners to develop procedures that will compensate for a prolonged loss of electric power.** Current policy assumes a Fukushima-scale disaster will not happen here—that workers will restore power before emergency batteries are depleted. The industry should prepare for a station blackout of more than a few hours.
- **Require plant owners to move older spent fuel to dry storage.** After five years in storage pools, spent fuel rods can be transferred to dry casks made of steel and concrete, which are more secure than pools. Transferring rods out of pools would also lower the risk of the remaining rods overheating and reduce the amount of radioactivity in the pools.
- **Revise emergency plans to ensure everyone at risk from radiation exposure—not just those within the 10-mile evacuation zone—will be protected.** In addition to expanding the evacuation zone and the distribution of potassium iodide tablets (which prevent the absorption of radioactive iodine by the thyroid gland), federal authorities should ensure there are sufficient resources to get people the help they need if a reactor accident overlaps with a tornado, earthquake, or other natural disaster.

When the NRC announced plans to examine its policies in response to the Japanese disaster, Lochbaum was not optimistic. "If the past three decades have demonstrated anything, it's that the NRC will likely come up with a solid action plan to address problems revealed at Fukushima, but will be glacially slow in implementing those identified safety upgrades," he told a Senate subcommittee. The NRC must do more than chart a course to a safer place—it must ensure that we actually reach that destination quickly.

Learn more about our efforts to improve nuclear power plant safety at *www.ucsusa.org/nuclear_power.*

Renewables Are Ready

Despite what lobbyists say, the United States doesn't need more nuclear *or* coal power.

According to our 2009 report *Climate 2030: A National Blueprint for a Clean Energy Economy,* the United States could meet its projected electricity demand for the next 20 years or more without building any new nuclear reactors or coal-fired power plants. Significantly increasing the efficiency of U.S. appliances, buildings, and power plants and expanding the use of renewable energy would be less expensive than building nuclear reactors or coal plants. By 2030, these strategies could reduce coal use and U.S. power plant carbon emissions by about 85 percent and lower Americans' annual energy costs by an average of $900 per household.

Photo: © NRC (spent fuel pool); © AP Photo/Tobey Talbot (dry casks)

The Signs Are Everywhere

Global warming is already affecting locales all over the world. A new UCS website illustrates the need to combat climate change by putting Earth's threatened places and ecosystems on the map.

By Nancy Cole

Why in the world are frozen lakes erupting in flames—and *where* in the world is this happening? Why is Earth's tiniest plant kingdom being threatened—and where can you find this wonderfully unique ecosystem?

For the answers to these questions and more, join the scavenger hunt in progress on our new website, Climate Hot Map (*www.climatehotmap.org*). This interactive site, which launched in June, allows you to trek all over the world, exploring the "hot spots" where the scientific evidence shows climate changes are already under way, and where scientists are now assessing the risks associated with further warming.

Change Is in Everyone's Backyard

UCS and six other organizations launched the original Climate Hot Map in 1999; now we have completely redesigned the site to take advantage of the wealth of climate data—and useful online tools—available today. The Hot Map aims to:

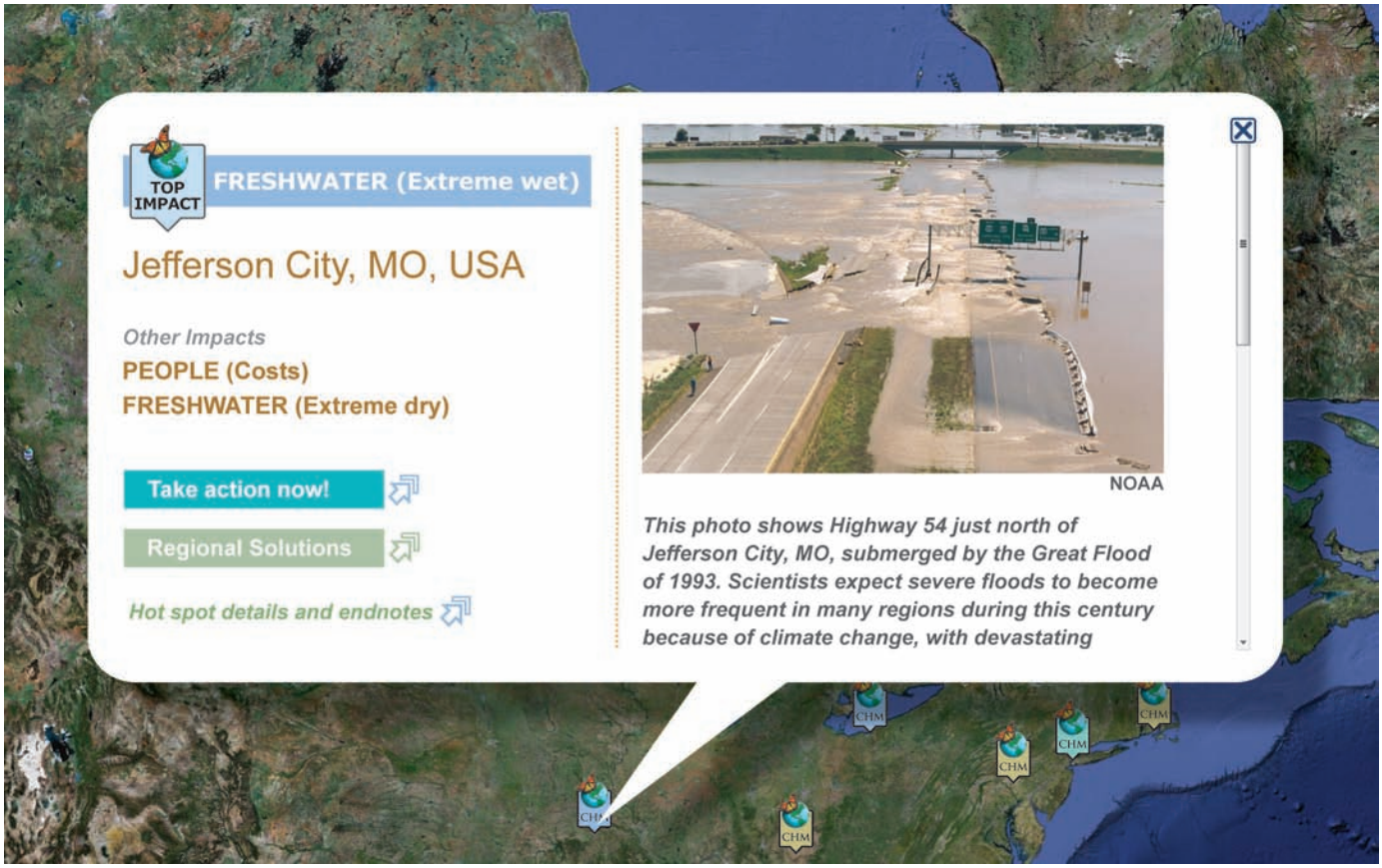
- Share the widespread and compelling evidence demonstrating that global warming is affecting our physical and biological world
- Emphasize the fact that climate change is a problem with consequences the world over
- Motivate visitors to do something about the problem once they see how places they know and love are at risk of irreversible change

Throughout the website, we provide information about solutions that will help prevent the worst consequences of a warming world.

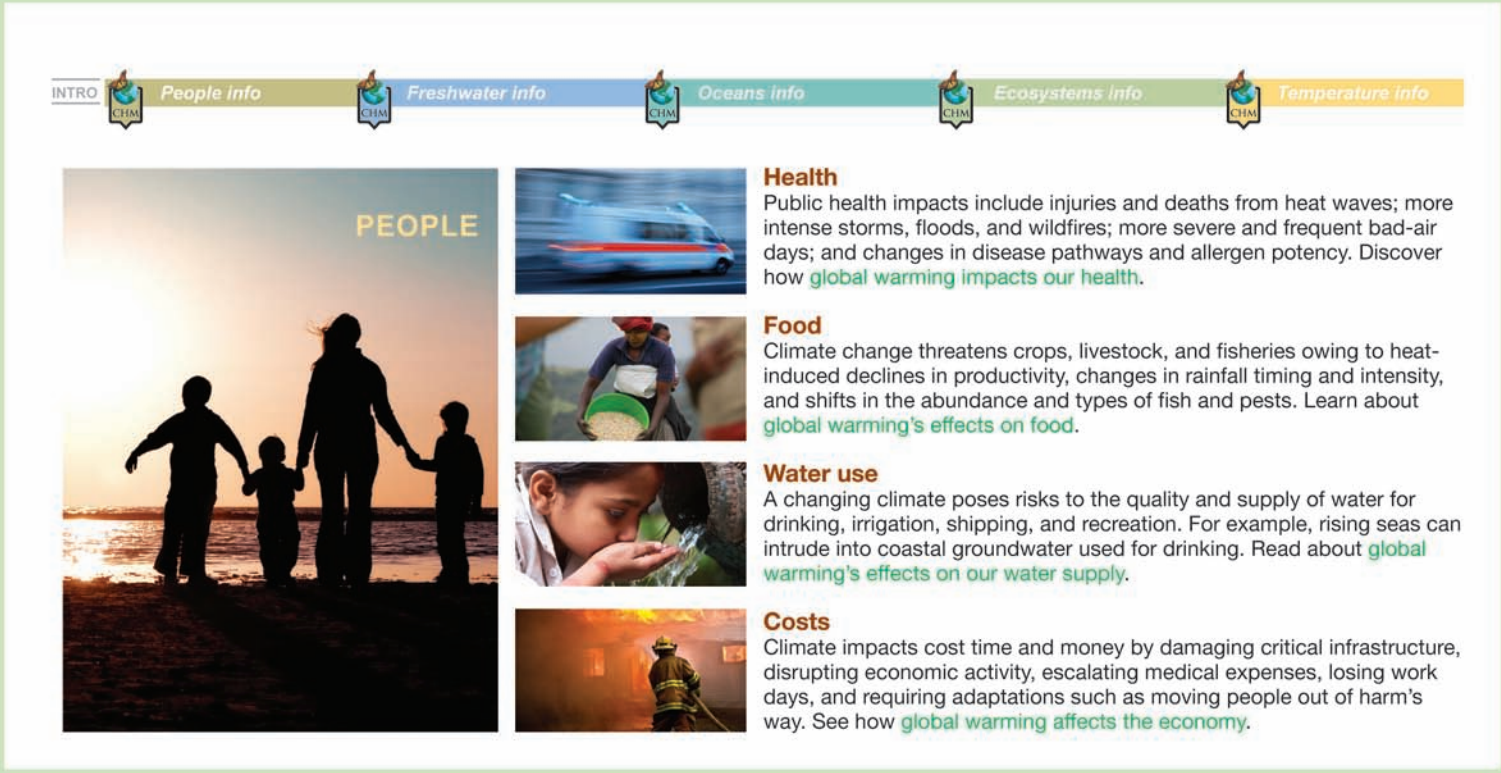
The website uses Google Maps to display 60 hot spots around the globe—on every continent and in most oceans—with more to be added in the months ahead. (Google Earth users can also see the hot spots in the program's Showcase section.) Hot spots are chosen based on three criteria: scientific robustness (i.e., a wealth of literature demonstrates the impact global warming is having in that location), multiple impacts in the same location, and compound stresses (i.e., global warming's impact is being exacerbated by destructive human activities such as overfishing, inefficient water use in drought-prone areas, or sprawling development).

Clicking on a hot spot icon opens a postcard-sized pop-up window featuring a photo and list of key facts summarizing how climate change is affecting that location and what that means for the people who live there. Jefferson City, MO, for example, will experience devastating flooding (similar to this past spring) more frequently. On the other side of the world, we show how shrinking glaciers threaten freshwater resources in the mountain town of Ürumqi, China. Each pop-up links to a more detailed description of the impacts in that location, cross-referenced with a glossary of technical terms and a list of the scientific literature used to develop the text. These detailed pages also discuss how changes in the local climate might be part of a larger pattern such as El Niño, and what scientists project could happen in the location a few decades from now.

Visitors can also view an index of hot spots by region, or search for hot spots based on the type of changes taking place. Hot spots fall into five major categories—people, freshwater, oceans, ecosystems, and temperatures—and each category is further divided into three or four types of impacts. The People category, for example, is outlined at the top of p. 12.



Clicking on a hot spot icon opens a pop-up window that illustrates how global warming is affecting that location.



The Hot Map explains the many ways in which global warming will affect the environment, economy, health, and well-being of global communities.

Local Solutions to a Global Problem

Thankfully, all is not doom and gloom on the Climate Hot Map. Throughout the website, we provide information about solutions that will help prevent the worst consequences of a warming world. Because global warming is caused by too much carbon dioxide and other heat-trapping gases distributed throughout the atmosphere, many solutions apply universally. However, each region of the world varies in terms of which sectors of the economy are releasing the most emissions, the vexing social and economic issues that contribute to the problem, and the capacity to prepare for those changes that are unavoidable. Taking this into account, we have organized solutions by region so visitors can see the highest priorities for each area of the world.

In addition to suggesting solutions applicable to either individuals or governments, we provide an opportunity for visitors to voice their support for policies that will get the world on a lower-carbon pathway. Whether you are viewing the home page, a hot spot, or a regional solutions page, you can click the Take Action button to send an email to key decision makers that urges them to get serious about global warming. You can also share the Climate Hot Map by using the Facebook and Twitter links on the home page and each hot spot.

Despite a prolonged economic recession, a dramatic shift in the U.S. political landscape, and a determined attack on science by climate change deniers (see "Perspective," p. 3), it is essential that we re-engage the public on the urgency of global warming and strengthen the political will for action to reduce heat-trapping emissions. The Climate Hot Map is one way UCS can help in this effort; by making the effects of global warming real and immediate, and showing how it is already having a potentially disastrous effect on places people know and love, we can help ensure these places will still be around for our children to love, too.

By making the effects of global warming real and immediate, and showing how it is already having a potentially disastrous effect on places people know and love, we can help ensure these places will still be around for our children to love, too.

***Nancy Cole** is director of outreach in the UCS Climate and Energy Program.*

Get started on the Climate Hot Map scavenger hunt today by visiting our website at *www.ucsusa.org/scavengerhunt.*

Concentrating Solar Power

When you think of solar energy, photovoltaic panels on rooftops probably come to mind. But if you have ever used a magnifying glass to ignite a piece of paper, you have dabbled in a primitive form of concentrating solar power (CSP). CSP (or solar thermal) plants apply this principle on a much larger scale, creating intense heat to generate clean, carbon-free electricity.

Parabolic troughs produce steam by concentrating sunlight on fluid-filled pipes.

How to Catch Rays

There are several different types of CSP technology. The most popular is the **parabolic trough**, which uses curved mirrors to concentrate sunlight onto fluid-filled pipes above each mirror. A similar technology, **linear Fresnel reflectors**, uses flat mirrors (rather than curved) to concentrate sunlight onto pipes. In both systems, the sun heats fluid in the pipes that then boils water, which creates steam that drives a turbine and generates electricity. The mirrors also track the sun's movement throughout the day, optimizing energy generation. There are 17 parabolic trough plants in operation around the world today; the first series of plants was built in California's Mojave Desert in the 1980s and, at 354 megawatts (MW) of generating capacity, remains the largest. In contrast, only three linear Fresnel plants are in operation so far.

Power towers use a large array of multiple flat mirrors to direct sunlight toward a single liquid-filled boiler atop a central tower. So far, there are five power towers operating in the world, and one under construction in the Mojave Desert—the Ivanpah project—will be the largest CSP plant in the world, with an expected generation capacity of 392 MW.

The least-used CSP technology to date is **dish/engine systems**, which use satellite dish-shaped mirrors to concentrate sunlight onto a Stirling engine. The sun's heat expands air or a gas, usually helium or hydrogen, in the engine and the resulting change in pressure powers the engine, generating electricity. Since this technology does not involve steam, much less water is needed—an advantage for the sunny, arid climates best suited for CSP. And since each unit generates its own electricity, it can be built on a smaller scale appropriate for targeted, local power needs. Arizona is home to the only dish/engine CSP plant in operation today, a demonstration unit with a generating capacity of 1.5 MW.

The choice of CSP technology is often driven by location-specific factors, but steam-driven systems have benefited from the fact that they use the same turbines as conventional gas- and coal-fired power plants, allowing them to be deployed more quickly and at a lower cost than technologies that require fully customized parts. In addition, unlike some other renewable energy technologies, CSP systems that use trough or tower technology can store the heat they collect and use it to generate electricity when the sun is not shining. The heat is either stored as a hot liquid or transferred to another substance like molten salt or graphite. For example, a 50 MW parabolic trough facility in Granada, Spain, can store seven hours' worth of electricity-generating heat. This thermal storage capability makes CSP more competitive with large coal and nuclear plants in terms of both output and reliability.

CSP plants create intense heat to generate clean, carbon-free electricity.

Photo: NREL/Warren Gretz

Power towers focus sunlight on a centralized boiler.

Slaking CSP's Thirst

As water becomes more scarce in a warming world, CSP plants must minimize their consumption.

CSP plants traditionally require significant amounts of water, primarily to cool the steam that drives the generating turbine. Water use estimates for such "wet-cooled" CSP facilities range from 700 to 1,000 gallons per megawatt-hour; in comparison, wet-cooled nuclear and fossil fuel plants use roughly 400 to 1,000 gallons per megawatt-hour.

Fortunately, a far less resource-intensive cooling technology exists: "dry cooling," which uses large fans instead of water to cool the steam. This can reduce water use at CSP plants by about 90 percent (water is still needed to wash the mirrors and compensate for any leaks in the steam pipes). However, dry-cooled CSP plants are less efficient—and therefore more expensive—than wet-cooled plants for two reasons: air is not as good as water at cooling steam, and a significant amount of electricity is needed to power the cooling fans, which reduces the plant's electricity output between 5 and 25 percent.

All the CSP plants operating today use wet cooling, but with increasing demands on freshwater supplies and conflicts over its use, plant owners will feel more and more pressure to conserve water. Some of the CSP plants recently approved for development in California, including the Ivanpah plant already under construction, will use dry cooling.

On the Horizon

The 26 CSP plants operating in the world today have the capacity to generate more than 1,200 MW of power (more than 430 MW in the United States). Although this is a minuscule total compared with the current capacity of fossil-fuel-fired power plants (a typical coal-fired plant has a capacity of 600 MW), the CSP industry has grown rapidly since the early 2000s and will continue to expand in market share. There are approximately 60 CSP plants under development around the world, 33 of which are planned for the United States (mostly in the desert Southwest).

One of the biggest obstacles to the growth of CSP will likely be economics; generation costs for CSP (per kilowatt of capacity) are declining, but not as rapidly as those for other renewable technologies, especially solar photovoltaics. The other important consideration, as with any proposed generation facility, is environmental impact. Most CSP facilities require large swaths of intensely sunny, relatively level land—as much as 5 to 10 acres per megawatt of capacity. The most suitable locations are usually desert ecosystems, so developers must take care to minimize or avoid disruption to natural habitats and protected species. CSP projects can also strain water supplies in areas where water is a scarce resource.

These hurdles are leading project developers to invest in low-water technologies (see the sidebar), arrange their mirrors more efficiently, and choose sites that have already been "disturbed" by previous activities, minimizing the project's impact on the land and its species. With help from strong state-level policies and federal tax incentives, combined with responsible permitting practices, CSP can play an increasingly important role in ending our national dependence on fossil fuels, combating the threat of global warming, and securing a future based on clean, safe, and reliable energy.

Thermal storage capability makes CSP more competitive with large coal and nuclear plants in terms of both output and reliability.

Laura Wisland *is a senior analyst in the UCS Climate and Energy Program.*

Learn more about CSP and other renewable electricity technologies in "Clean Energy 101," online at *www.ucsusa.org/clean_energy/clean_energy_101*.

Photo: Sandia National Laboratories/Hugh Reilly

Acolytes of Mother Nature

To Chris and Emily Boniface, a couple living in Portland, OR, the natural world is a temple for worship. "The environment is inseparable from everyone's daily life," Emily says, to which Chris adds, "Even when you live in the concrete jungle of the city."

Growing up, Chris's playground was the forest and streams around his house in rural Oregon. Though the couple's careers in biomedical research led them to live in the city, they appreciate the fact that urban living allows them to bike to work and walk to restaurants, shops, and public transportation. And being a short drive from both the ocean and mountains, they can still stay connected with the region's natural beauty. Back at home, they have a small garden that provides them with radishes, tomatoes, lettuce, carrots, peas, and cucumbers; they've also planted a dogwood tree—as suggested by our *Climate-Friendly Gardener* guide—to help shade their home (which reduces summer cooling costs) and absorb carbon dioxide.

UCS recognizes the importance of engaging young scientists like the Bonifaces in our work.

Chris and Emily value the role UCS plays in bringing science to the table where important policy decisions are made. Members of our Henry Kendall Society, they both grew up understanding that climate, energy, and security issues need to be addressed through government policy, and are willing activists for the cause. UCS, in turn, recognizes the importance of engaging young scientists like the Bonifaces, who are passionate and informed, in our work. In 2009 we asked Chris to represent UCS at a meeting with newly elected Oregon Senator Jeff Merkeley's staff about the risks of reprocessing nuclear waste. Chris says, "It was awesome to have a chance to speak to the senator," and we think Chris was pretty awesome himself.

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