



Union of Concerned Scientists

Catalyst

SPRING 2010

SECURING THE SKIES

How we can avoid
an arms race in space

Also: Small Businesses & Climate • How Cover Crops Work

Catalyst,
ISSN 1539-3410, is
published three times a year
by the Union of Concerned
Scientists. Text of articles
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COVER PHOTO
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 *Catalyst* is printed
on chlorine-free
recycled paper with 60%
post-consumer content.

The Union of Concerned
Scientists is the leading
science-based nonprofit
working for a healthy
environment and a
safer world.

This publication is financed
by contributions from
individual members; you
can join UCS by sending a
tax-deductible contribution
of \$25 or more to UCS
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The Hidden Costs of Nuclear Power

The article “Nuclear Economics 101” [Fall 2009, p. 11] did not mention nuclear fuel production or waste storage costs. What is the present state of those issues?

Thomas McCabe, Culver City, CA

Your article “Nuclear Economics 101” misses two huge points about costs: the government’s subsidies for nuclear fuel production and accident insurance. Don’t these factors also affect the economic viability of nuclear power?

James Eisenstein, Boalsburg, PA



The author responds:

Fuel costs constitute about 25 percent of the total operating and maintenance costs for U.S. reactors—about \$40 million a year for a typical 1,000-megawatt plant. Ratepayers pay about \$8 million a year through their utility bills to fund nuclear waste disposal, while the nuclear industry pays about \$2 million per reactor annually to store waste on-site. The costs incurred by taxpayers as a result of the Price-Anderson Act, which limits the industry’s liability in the event of an accident, are difficult to quantify.

These costs pale in comparison with the more than \$100 billion in federal loan guarantees sought by the industry to underwrite a new generation of reactors. This would further mask the true cost of nuclear power as a potential climate solution compared with safer, more affordable renewable alternatives.

Elliott Negin, media director

Biotech beyond Our Borders

Can you explain why “Failure to Yield” [Summer 2009, p. 11] ignores international data showing [some] genetically modified crops have significantly higher yields? For example, the use of *Bt* cotton in India? This is particularly puzzling since you mention that farmers in developing countries have the greatest need to improve crop yields.

Thomas L. Noland, Sault Sainte Marie, Ontario

The author responds:

Our report was motivated by the global food crisis and the biotechnology industry’s response to it, so we did not include cotton in our analysis. More generally, we relied on U.S. studies because of their greater number and, importantly, because they include research that allows us to distinguish between the contribution of the engineered gene to crop yield and the contribution of the crop variety overall. Crops contain many yield genes, and yield varies considerably between crop varieties, so only certain experiments pinpoint the contribution of the engineered gene.

Engineered crops have sometimes provided higher yields in developing countries, but many methods can improve yields for poor farmers. U.S. data give us a better sense of how engineered traits stack up against other agricultural technologies that may be transferred to developing countries. For example, corn yields here rose about 28 percent over the past 13 years, but engineered traits contributed only about 3 to 4 percent.

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



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

Getting the Climate Story Straight



For years, scientists who wanted to raise public awareness of global warming’s dangers have had to fight industry-funded contrarians and their inaccurate claims about climate science. The tide started to change when the Intergovernmental Panel on Climate Change concluded in 2007 that human activity was contributing to global warming; reporters realized they no longer needed to balance their stories with opposing viewpoints since the science on climate change had become clear. As a result, it became more difficult for contrarians to get quoted in news stories—which would serve their larger goal of undermining federal climate and clean energy legislation.

However, following the U.S. House of Representatives’ passage last summer of the first bill requiring nationwide reductions of heat-trapping emissions, the fossil fuel industry and its allies ramped up their efforts to spread scientific misinformation. In November, for example, after a hacker stole emails sent by climate scientists at a British university, contrarians quoted some of the emails out of context, further undercutting the public’s understanding of climate science. Many mainstream media outlets unfortunately viewed this manufactured controversy as a real scandal and reported the contrarians’ claims at face value. This is particularly frustrating considering the overwhelming and ever-growing evidence—from melting ice caps to worsening floods and more intense storms—of the serious consequences of global warming.

UCS played a critical role in putting those emails into context and helping reporters from the *Washington Post* to the *NBC Nightly News* tell the real story: that a bunch of stolen emails doesn’t change the basic science. Yet this was only one battle in a bigger fight. Conservative talk show hosts, bloggers, and columnists continue to use the weak economy as an excuse to derail decisive action against climate change—even though the science clearly shows we cannot afford to wait. Recent research has confirmed that the consequences of global warming are occurring at a faster pace, and at a greater magnitude, than expected, and that the cost of delaying action continues to grow.

Our pockets may not be as deep as the fossil fuel industry, but over the years our scientists have earned the respect of journalists by helping them understand and communicate the connection between global changes and local communities—the people who consume their news. It’s one way in which UCS continues to influence public opinion and move policy makers to act responsibly.

—Kevin Knobloch, president

Conservative media outlets continue to use the weak economy as an excuse to derail decisive action on climate change.



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Clearing the Air

UCS wins return to science-based standards

The Environmental Protection Agency (EPA) is poised to end one of the most egregious Bush administration abuses of science: a refusal to create science-based air quality standards for ground-level ozone (the primary component of smog), which is associated with respiratory ailments and premature death. UCS and our activists have been pushing for this change since early 2008, when the EPA caved in to White House pressure by setting ozone standards that would not adequately protect public health—in the process misrepresenting recommendations from its own scientists and an independent advisory committee.



UCS testified before Congress, spoke to the press, encouraged activists to file thousands of public comments, and, in meetings during the presidential transition, asked the new administration to revisit the EPA's decision. The agency suspended the flawed standards in January of this year and proposed welcome new standards consistent with the scientific consensus, but polluting industries are already working to keep the previous rule in place. As *Catalyst* went to press, UCS was mobilizing scientists to speak in favor of the proposed standards at public hearings nationwide.



A Victory for Vehicle Fuels

Our support strengthens biofuels standard

A new rule released by the Environmental Protection Agency in February will help ensure that biofuels such as ethanol contribute to a meaningful reduction in the environmental impact of transportation fuels. The federal renewable fuel standard (RFS) will now require fuel suppliers not only to use an increasing percentage of biofuels but also to reduce—for the first time ever—the heat-trapping emissions of biofuels. These reductions will be calculated over a fuel's entire life cycle (from the growing and harvesting of crops to their conversion into fuel) and include emissions from changes in land use as demand for fuel from agricultural crops rises.

The corn ethanol industry lobbied hard to exclude land-use emissions from the final rule, but UCS avoided that setback by bringing together more than 200 experts in support of a rule based on the best available science. To learn more about the RFS, visit the UCS website at www.ucsusa.org/smartbioenergy.

Science Influences Copenhagen Accord

But UCS pushes for more ambitious action

In December, a team of top UCS scientists, economists, and policy analysts traveled to the United Nations' climate summit in Copenhagen, Denmark. We met with U.S. and foreign delegates, officials, journalists, and other attendees over the course of the two-week meeting, sharing our concerns and offering recommendations on key issues relating to the treaty negotiations.

While the summit did not result in the ambitious, binding treaty the planet needs, the Copenhagen Accord hammered out by President Obama and other world leaders does set a maximum limit for the increase in global average temperature, and calls on all countries to put forward specific emissions reduction pledges, as



The Accord highlights the need for actions to reduce deforestation.

well as to monitor and report on their emissions. We are pleased that the Accord also highlights the need for actions to reduce deforestation and

forest degradation, which are responsible for approximately 15 percent of heat-trapping emissions worldwide.

Alden Meyer, director of strategy and policy at UCS and a 20-year veteran of the negotiations, pressed negotiators from the United States and other countries on their commitments, and served as an adviser to the Danish minister of climate and energy (who served as president of the conference). UCS President Kevin Knobloch provided important scientific information to delegates, and our media staff connected our experts to the world press to provide updates and commentary. To learn more about our role in Copenhagen and watch interviews with UCS staff at the conference, visit our website at www.ucsusa.org/cop15videos.

Biotech Fails to Stop Weeds

GE crops actually increase pesticide use

The biotechnology industry has touted the ability of genetically engineered (GE) crops to reduce pesticide use in agriculture. However, a November 2009 report funded by UCS and other groups has found the opposite to be true. *Impacts of Genetically Engineered Crops on Pesticide Use in the United States: The First Thirteen Years* draws upon U.S. Department of Agriculture data to compare pesticide use between GE and non-GE crops. The report shows that, since 1996, U.S. farmers have applied 383 million *more* pounds of herbicides

The report identifies the primary cause of the increase to be herbicide-resistant weeds.

(weed killers) on GE crops than they likely would have applied on non-GE varieties of these crops. This increase in herbicide use far outweighs the decrease in insecticide use attributable to GE crops, meaning today's GE crops require more pesticides than their non-GE counterparts overall.

The report identifies the primary cause of the increase to be herbicide-resistant weeds, which have emerged

A Toast to 40 Years of Science in Action



UCS President Kevin Knobloch, UCS Chairman James McCarthy, and former UCS President Bud Ris celebrated our fortieth anniversary at a dinner last October with more than 140 UCS colleagues and supporters. Featured speakers at the dinner also included Nobel Laureate Harold Varmus.

For more information on the symposium speakers and program, go to www.ucsusa.org/40thanniversary.



Nearly 300 people participated in our science and policy symposium; one session on the intersection of science, policy, and media featured Nobel Laureate and UCS Board Member Mario Molina, *Boston Globe* editorial writer Don MacGillis, former U.S. Representative John Porter (R-IL), and National Public Radio host Steve Curwood.



U.S. Representative Ed Markey (D-MA) gave the symposium's keynote address, praising the role UCS has played in providing the scientific information needed to shape critical legislation.

as a result of increased herbicide use on widely planted GE soybean, corn, and cotton crops. As a consequence, weed control in farmers' fields is now a serious problem, particularly in the Southeast but increasingly so across the Midwest. To learn more about the report and less-damaging agricultural approaches, visit the UCS website at www.ucsusa.org/pesticide-increase.

Locals Have Say on Global Warming

We bring senators, constituents together

Last November, as the Senate Environment and Public Works Committee was preparing to consider a landmark climate bill, UCS brought 32 experts to Washington, DC, to discuss climate and energy issues with their senators and their staffs.

Participants and UCS staff met with people in 37 different congressional offices, urging their lawmakers to pass a strong climate and energy bill.

The participants—including scientists, economists, business leaders, and farmers—hailed from 10 states whose senators are undecided on climate policy.

At an opening workshop for the participants, UCS staff provided an update on the status of climate science and legislation, and trained participants on conducting effective meetings with

policy makers. The following day the participants and UCS staff met with people in 37 different congressional offices, relating their stories and



urging their lawmakers to improve, defend, and pass a strong climate and energy bill.

UCS held a total of four such expert events last year. Participants from each event helped UCS generate media coverage in their states, and many of the respective congressional offices expressed appreciation for their constituents' well-informed comments on the scientific and economic arguments for climate action. As *Catalyst* went to press we were preparing to bring a new group of scientists, economists, and business leaders to the nation's capital to increase the pressure on these senators to take action on climate change.

UCS workshop participants John Campagna (left, an ecosystem services finance expert) and Janis Gunel (right, a green jobs trainer) met with a representative from the office of Senator Robert Byrd (D-WV), who is depicted in the painting shown here.

Calling All Scientists

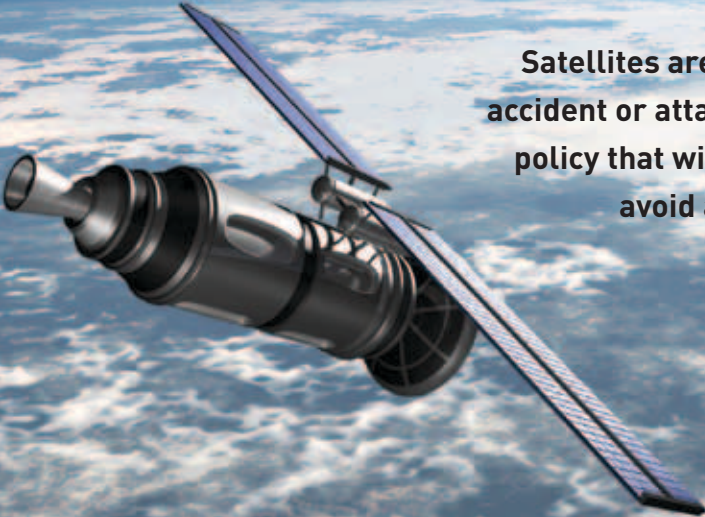
UCS helps your voice be heard

If you are a scientist, engineer, health professional, or economist with (or working toward) an advanced degree, we invite you to join the UCS Science Network (www.ucsusa.org/sciencenetwork) and apply your expertise in a way that can truly make a difference. You will receive timely action alerts and invitations to online and in-person events specifically related to your field of expertise, and you'll also be among the first to learn about new UCS reports and analyses.

As a subject expert, you can help us address some of the most critical environmental, public health, scientific, and security challenges of our time. Your knowledge and recommendations can motivate policy makers and business leaders alike to take positive steps toward meaningful solutions.

Even if you do not have an advanced degree, you can still get involved in our efforts by signing up for action alerts and our new monthly e-newsletter at www.ucsusa.org/join.

SECURING THE SKIES



Satellites are highly vulnerable to damage from accident or attack. UCS recommends changes in U.S. policy that will protect these valuable assets and avoid an arms race in outer space.

The nature of space operations has changed dramatically in the 50 years of the Space Age. Today more than 50 nations own satellites or a significant share in one, and commercial operators own more satellites than nations do. The nearly 1,000 active satellites now in orbit (see the figure, p. 8) have assumed critical roles in banking, telecommunications, navigation, and other civilian, scientific, and military activities.

However, the existing laws and norms relating to the use of space have not kept pace with these changes. For example, the Outer Space Treaty (OST) of 1967 designated space as “the province of all mankind” and forbade the stationing of weapons of mass destruction in space, yet no organization was ever created to interpret the OST’s guidelines, moderate disputes, or verify that its signatories are complying with its tenets. As a result, the space above Earth has come to resemble the Wild West, with ever more satellites and few restrictions on behavior, increasing the risk of accidents (see the sidebar, p. 9) and of misunderstandings that could lead to conflicts on the ground.

U.S. policy in the last decade focused on securing space via unilateral and military means, and some policy makers were skeptical about the ability of diplomacy or new laws to serve U.S. interests. The Obama administration has indicated that it will take a different approach. To help reshape U.S. policies on civil, commercial, and military space and re-engage the international community on space security, UCS worked with experts in the security community to identify high-priority steps

By Laura Grego

the United States should take to ensure the sustainability of the space environment, keep satellites safe, and enhance stability in space and on the ground.

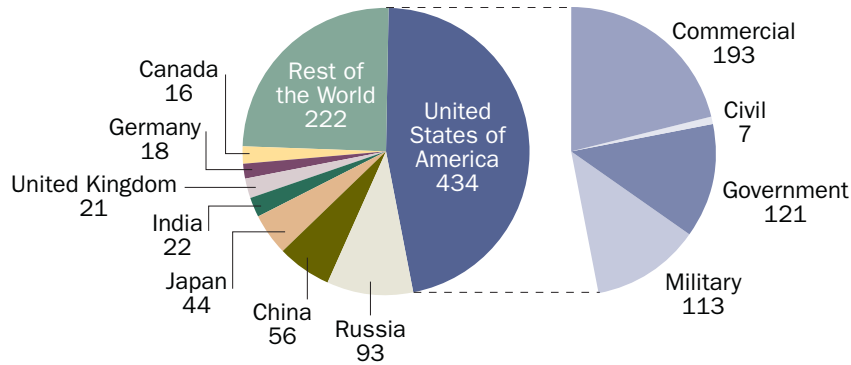
Setting Long-Term Goals

A successful space security regime could be constructed in many different ways. For example, nations could revise and expand the Outer Space Treaty or negotiate new laws, devise coordination strategies and codes of conduct, and/or implement technical solutions for keeping satellites safe. Regardless of which strategies are ultimately adopted into a long-term plan, UCS recommends that the plan be constructed to meet these goals:

- Ensure the long-term, sustainable use of space
- Permit safe access to space for all, with minimum interference (from debris or signal jamming, for instance)
- Prevent activities in space from increasing tensions between countries or leading to arms buildups
- Prevent activities in space from sparking or exacerbating crises on the ground

The physics of space requires a multilateral approach to meeting these goals. Because satellites are in constant motion above Earth, travel at high speeds, and tend to use similar orbits, close coordination between satellite operators in this increasingly crowded environment is necessary to avoid unintentional interference and even collisions, which can produce debris that

Satellites Currently in Use



Because the United States owns far more satellites than any other nation, it has the most to lose should nations develop and deploy weapons that can destroy satellites and create dangerous debris. Damage to satellites can disrupt vital communications or hinder important research such as climate monitoring.

Source: UCS Satellite Database, www.ucsus.org/satellite_database

remains in orbit for decades or centuries (posing a long-term threat to other satellites). Satellites also cannot be reliably protected from deliberate attacks via unilateral and military means. Because the actions of one nation can harm all space users, the secure use of space hinges on global cooperation and awareness.

Protecting Satellites and the Space Environment

An important step toward achieving the goals listed above is to ensure that satellites currently in space are kept safe from damage or attack. To that end, UCS recommends the United States take the following initial steps to secure its space assets:

Reduce the impact of an attack on U.S. satellites. The United States should design its critical satellite systems to be able to continue providing services even if individual satellites are compromised. This can be achieved by building redundant capability in multiple satellites or distributing a single satellite's workload among clusters of satellites. Satellite systems can be further strengthened by using protective measures such as anti-signal-jamming technology, and by developing ground- and air-based backup systems for high-priority functions such as navigation and communications. These efforts would also reduce the incentive to attack U.S. satellites in the first place, since there would be less to gain from their loss.

Declare a moratorium on the intentional disabling or damaging of satellites. Such a moratorium would preclude U.S. action against its own defunct or malfunctioning satellites as well as satellites of other nations. This would limit the operational development of anti-satellite (ASAT) weapons, in turn assuring other countries that the United States is serious about mutually agreed-upon limits on dangerous technologies. It would also set a standard that other countries need to meet to be considered credible partners in space security negotiations.

Pledge not to be the first nation to station dedicated weapons in space. Russia made such a pledge in 2004, and is currently the only nation to have done so. By following suit, the United States can encourage other space powers to take similar action. Because being the first to put a weapon in space conveys no lasting advantage, the United States does not cede the "high ground" by making such a statement.

Pledge not to develop or deploy space-based missile defense interceptors. The Bush administration had proposed space-based missile defense research and development that would, for the first time, place dedicated weapons in orbit. As UCS and others have shown, space-based missile defense would be technically challenging and enormously expensive, and could be easily defeated by a determined enemy, so a full system is unlikely to be realized. However, even a few "test" interceptors in orbit may be viewed as a threat by other countries. While

The space above Earth has come to resemble the Wild West, with ever more satellites and few restrictions on behavior, increasing the risk of costly accidents.

Congress has repeatedly refused to fund this proposal, a pledge not to pursue space-based missile defense would represent a more durable commitment.

Pledge not to use any land-, sea-, or air-based missile defense systems to attack or destroy a satellite. Long-range missile defense technologies currently under development may prove to be much more effective at targeting satellites than ballistic missiles. This pledge would prohibit nations from testing this potential capability, thus reducing their confidence in using a missile defense system in this way.

We Need to Talk

Ultimately, true space security will depend on an open dialogue between space-faring nations. UCS calls on the United States to restart the process by taking the following steps:

Bring leadership to international discussions. Because it is the largest user of space, and because it has a history of opposing space security negotiations, the United States must be an active and cooperative participant for international efforts to succeed. The United States should collaborate with other space

users to identify the most productive venue for negotiations and lay out an agenda that covers the full range of space security issues and includes a variety of approaches for solving them (such as treaties and/or less formal cooperative agreements).

Assemble a negotiating team with the appropriate expertise. Because of the lack of serious engagement on space security issues for many years, the United States and other coun-

The United States is the country most invested in space and most poised to benefit from a comprehensive, multilateral space security plan.

tries do not have in place people with the diplomatic, technical, and legal expertise required to make these discussions bear fruit.

Review and modify regulations that hinder cooperation on commercial and civil space activities. The United States has not fostered space cooperation with the international community in general, but it has taken a particularly strong stance against China, blocking Chinese access to all U.S. space and missile technology. Cooperation between the United States and China on peaceful, scientific uses of outer space could build the level of trust needed for a comprehensive space security regime.

Is Progress in the Stars?

The United States is the country most invested in space and most poised to benefit from a comprehensive, multilateral space security plan. Creating such a plan will take leadership and sustained engagement by the United States, and the Obama administration has the opportunity to lay the groundwork for meaningful action. It is in the process of rewriting the National Space Policy, which guides U.S. space activities across all sectors (e.g., civil, commercial, government, military), while priorities for the national security uses of space will be established in the first-ever Space Posture Review, slated to be completed in 2010.

President Obama also seems to understand that a working relationship with China is important to achieving true space security. In a joint statement issued with President Hu Jintao in November 2009, he stated that, “The two countries have common interests in promoting the peaceful use of outer space and agree to take steps to enhance security in outer space.”

UCS is playing an active role in shaping the Obama administration’s policies, and we are currently briefing U.S. policy makers about the recommendations described in this article.

Laura Grego is a senior scientist in the Global Security Program.



Satellites currently face risks from missiles and other satellites.

Wanted: Order on the Final Frontier

Recent events demonstrate the need for better coordination and monitoring of space activity.

As the following incidents show, existing laws and systems governing space operations are not up to the challenge of keeping space safe.

- In 2007, China intentionally destroyed one of its aging weather satellites with an ASAT weapon, producing more than 100,000 pieces of dangerous orbiting space debris. Not only was this test one of the single largest debris-producing events in Earth orbit, it was also the first destructive ASAT test by any country in 20 years. While this demonstration flouted international norms, it did not violate any laws.
- In 2008, the United States used a sea-based missile defense interceptor to destroy one of its own failed satellites, vividly demonstrating how missile defense systems could double as ASAT weapons. Restrictions on missile defense systems ceased when the United States withdrew from the Anti-Ballistic Missile Treaty in 2001.
- In 2009, for the first time, intact satellites collided in orbit, producing an enormous amount of debris—nearly as much as the Chinese ASAT test.



Visit the UCS website at www.ucsusa.org/nuclear_weapons_and_global_security later this spring to download our full list of recommendations for ensuring the safe and peaceful use of space.

Climate for Success

UCS shows how California's climate policies can reduce global warming pollution—with little financial impact on the state's many small businesses.

By Erin Rogers

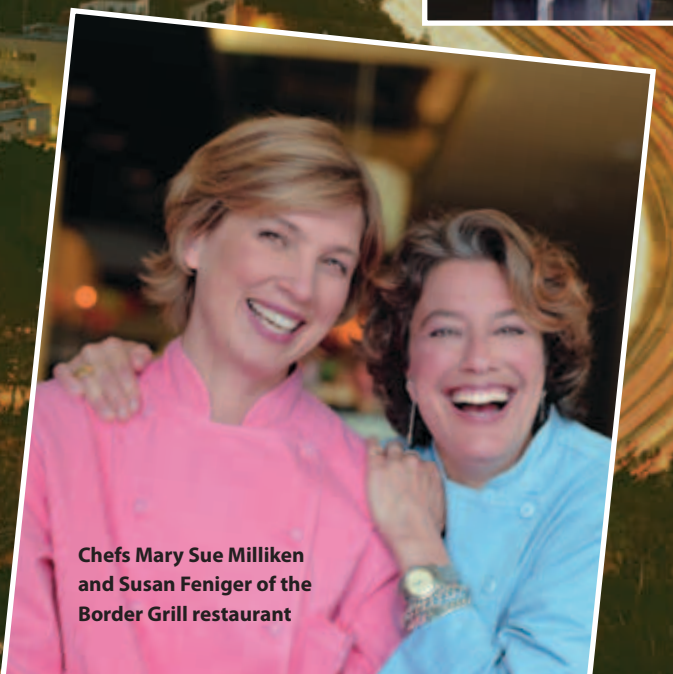
In 2006, California passed into law Assembly Bill (AB) 32, the Global Warming Solutions Act, which requires the state to reduce its heat-trapping emissions approximately 12 percent below current levels by 2020. The state is currently designing a mix of policies to reach this target, including: a renewable electricity standard that requires utilities to expand their supplies of clean power; a reduction of global warming pollution from vehicles and transportation fuels; higher energy efficiency standards; and a cap-and-trade program that would limit emissions from power plants and other industries.

Several economic studies have shown that California's economy will benefit from AB 32. However, in an effort to stop these policies from taking effect in 2012, many of the state's large polluters and their lobbyists claim that emissions reduction policies will harm California's more than 700,000 small businesses. To provide some clarity in this debate, UCS commissioned *The Economic Impact of AB 32 on California Small Businesses*, a first-of-its kind, peer-reviewed economic analysis.

Working with independent consulting firm The Brattle Group, we found that even if California's small businesses do nothing to decrease their energy use between now and 2020, they are likely to experience only a small and manageable impact from emissions reduction policies, while also reaping the benefits of new technologies and jobs created by a low-carbon economy.

Low Cost, High Returns

For the analysis, the Brattle Group reviewed empirical data on the energy intensity (i.e., the percentage of revenue spent on heating, electricity, and transportation fuel) of hundreds of types of small businesses. One of the most surprising findings to emerge from the data is that the average small business in California spends only 1.4 percent of its revenue on energy-related costs. Since most of these businesses do not emit enough pollution to be directly regulated by AB 32, they will only be affected by the policies listed above indirectly (to the extent that energy prices change as a result of AB 32). The analysis therefore concludes that California's global warming policies will only increase the amount its small businesses must spend on energy to 1.7 percent of total revenue—an increase of a mere 0.3 percentage points—in 2020.



Chefs Mary Sue Milliken and Susan Feniger of the Border Grill restaurant

This estimate is actually quite conservative because the report does not factor in the full range of cost savings that small businesses could see after investing in energy efficiency. For example, by replacing older appliances and heating equipment with newer, highly efficient Energy Star-rated models, using compact fluorescent and LED lighting instead of incandescent bulbs, or improving insulation, most businesses could lower their energy use significantly and offset the small increases in energy costs stemming from AB 32.

Furthermore, the 0.3 percentage-point increase in energy-related expenses we project for small businesses (assuming they make no investment in energy efficiency) pales in comparison to the effect of inflation. For a specific example of the significant difference in impact that AB 32 and inflation would have on a California small business over the next 10 years, see the sidebar.

The 0.3 percentage-point increase also falls well within the range of historic cost variation most small businesses face every day regardless of climate policies. The analysis found that the likely increases in electricity, gas, and transportation fuel costs due to AB 32 would be lower than recent increases caused by factors wholly unrelated to environmental regulations. In addition, these higher energy prices will have only a modest impact on the cost of products used by small businesses (e.g., food, supplies, services).

An Investment in a Lower-Carbon Future

If global warming is allowed to continue unchecked, its harmful impacts are expected to cost the United States hundreds of billions of dollars by the end of the century. Many businesses—including those in the recreation, tourism, agriculture, real estate, and forestry sectors—could suffer severe financial damage (in California and other states as well).

Conversely, policies aimed at cutting global warming pollution can benefit businesses by acting as an economic driver, creating jobs and new industries, attracting venture capital and other sources of funding, and making businesses more efficient and more competitive. Implementing policies such as AB 32 is therefore a win-win-win for businesses, consumers, and the environment.

Erin Rogers is the Western Region climate program manager at UCS.



Small businesses have much to gain from policies that promote a low-carbon economy. Learn more about the specific economic impacts of California's climate policy at www.ucsusa.org/small_business.

Border Grill: A Case Study

The only extra heat this restaurant wants is in its spicy entrees.

Border Grill, a Mexican restaurant in Santa Monica owned by chefs Mary Sue Milliken and Susan Feniger, has been in operation for nearly 20 years and currently employs 79 people. Because it relies on gas flames for cooking and lots of electricity for refrigeration, lighting, and air conditioning, the restaurant uses more energy than the typical small business. This, along with the fact that restaurants and bars account for the largest share of employment in any small-business category (10 percent of the statewide total), made Border Grill a good case study for the analysis of AB 32's economic impact on California's small businesses.

Milliken and Feniger generously provided us with detailed information on the restaurant's equipment, lighting, energy use and costs, and financial performance over the past five years. The Brattle Group developed a 10-year cash-flow projection based on these data, factoring in projected energy price increases resulting from AB 32.

Assuming that Border Grill would pass on to its customers any incremental changes in its energy costs due to AB 32, the cost of a typical dinner would only rise about 0.1 percent by 2020—or less than three cents for every \$20 spent. That pales in comparison to the effect of inflation over 10 years: a typical increase of 2 percent per year would add \$4.38 to a \$20 bill.

"Such a minuscule increase, even if noticed, would not cause our customers any heartburn," Milliken and Feniger said in a joint response to the findings. "We're known as the 'Too Hot Tamales' [from their television series of the same name] and we're worried about a Too Hot Future. Our customers are just as worried as we are, and would be more than willing to pay an extra three cents to help avoid the most catastrophic impacts of global warming."





Dealing a Blow to Global Warming

Cool It!, a new card game from UCS, aims to teach kids that climate change is a problem we can solve—provided we choose the best policies and technologies.

Im a card game nerd,” says UCS Press Secretary Aaron Huertas. He is also a science nerd who read Carl Sagan’s *Cosmos* when he was 12. So it surprised few of his colleagues when Aaron arrived at the office one Monday morning and announced that he had invented a global warming card game for kids.

“I read a *Washington Post* article that weekend about how children are afraid of climate change,” he says, “and it struck me that it’s because the media covers it with scary images and doesn’t focus enough on solutions. Kids often don’t understand that we have a choice about how bad global warming could get.”

Creating an educational tool for children is a new endeavor for UCS, but we are convinced that *Cool It!* will enable teachers and parents to talk about global warming in a fun and hopeful way. Kids, meanwhile, will learn that all of us make choices that determine whether the world warms a little or a lot, and which of those choices will help us make the necessary reductions in global warming emissions. “Games are a great way to teach young people how the world around us works,” Aaron says. “It takes the abstract and makes it real.”

Playing Our (Climate) Cards Right

Aaron worked with both UCS staff and a science educator affiliated with the National Science Teachers Association



Cool It! creator Aaron Huertas plays a prototype version of the card game with schoolchildren in New Jersey.

(NSTA) to refine his ideas. The finished game requires at least three or four players (more can be added with additional decks) and is appropriate for ages eight and up. To win, a player must collect a certain number of “solution” cards in the categories of energy, transportation, and forests; players can slow each others’ progress by playing “problem” cards in those same categories. In the process, kids learn about the ways in which heat-trapping carbon dioxide emissions are created and the best solutions for reducing those emissions.

Games help teachers and parents talk about serious issues in a fun and hopeful way.

UCS Communications Director Suzanne Shaw tested a prototype of the game by playing it with 20 children on “science night” at her children’s elementary school in Cambridge, MA, while Aaron played the game with kids after delivering a speech at a parochial school in Mount Holly, NJ. Aaron’s appearance was even featured in the town newspaper.

“Students got the hang of the game immediately and, most importantly, had a lot of fun learning about the cool clean technologies available to reduce emissions,” Aaron says. “A lot of parents are worried about talking to their kids about global warming. Our game helps kids understand that, yes, global warming is a big problem, but there’s still a lot we can do.”

So were kids still scared about global warming after playing the game? “Only one boy cried,” Aaron says. “But it was because he lost.” As *Catalyst* went to press, UCS was preparing to unveil *Cool It!* at the NSTA’s annual conference in Philadelphia, along with an elementary and middle school teachers’ guide developed by the science educator who worked with Aaron on the game.



Cool It! costs \$7.95. You can purchase the game, learn the rules, or read the teacher’s guide on the UCS website at www.ucsusa.org/coolit.

Cover Crops

Soil is arguably the most prized component of agricultural ecosystems. Healthy soil drains well, is rich in organic matter, and teems with life, including many beneficial microbes and insects. One of the most effective methods for developing healthy, productive agricultural soil—which has important benefits for the environment as well—is the use of cover crops.

A mainstay of organic farming systems, cover crops (often grasses, legumes, or cereal grains such as rye and winter wheat) are not meant to be harvested but rather to stabilize and improve soil that would otherwise remain bare when crops for harvest and sale—“cash” crops—are not growing. Because they are often planted in fall, cover crops have been described as a winter blanket for soils, helping to reduce erosion and water runoff by buffering the soil from rain and wind. They also suppress weeds and increase the soil’s water-holding properties, thereby improving the ability of cash crops to withstand drought. And when cover crops are plowed under in the spring, their organic matter improves soil structure to enhance drainage and root growth, and provides nutrients for both the sub-

sequent cash crop and a wide variety of beneficial organisms.

Among the most useful cover crops are legumes (e.g., beans, peas, vetches, clovers), which provide significant amounts of nitrogen to subsequent crops naturally, reducing the need for synthetic fertilizers. They do this by “fixing” nitrogen—converting it from the abundant but unusable form in the atmosphere into forms that plants can use—through a symbiotic partnership with common soil bacteria (see the sidebar, p. 14). When the cover crop is plowed under, microbes break down its molecules, releasing nitrogen into the soil for use by the subsequent cash crop. In this way, leguminous cover crops can supply most or all of the nitrogen needed for subsequent crops to produce high yields, allowing farmers to substantially reduce—or even eliminate—their use of synthetic nitrogen fertilizers, which cause serious pollution problems.

Reducing Pollution

Plants are unable to absorb more than half of the nitrogen fertilizer currently applied on U.S. farms, and much of the excess leaves the soil. This excess nitrogen threatens both the environment

and public health in a number of ways.

For example, nitrogen overuse in agriculture is the largest domestic, human-caused source of nitrous oxide, a global warming gas nearly 300 times more potent than carbon dioxide. Additionally, nitrogen runoff or leaching from farms in the Mississippi River watershed is the largest contributor to the Gulf of Mexico’s “dead zone”—an area the size of Connecticut and Delaware combined, where algae that flourish in conditions of excess nitrogen start a cycle that robs the water of oxygen, making it uninhabitable for fish and other marine life.

Nitrogen in the form of nitrate can also become a threat to human health when it seeps into drinking water. And finally, airborne ammonia (formed from the nitrogen in fertilizer) contributes to smog, respiratory diseases, and acid soil.

In response to mounting nitrogen pollution, the biotechnology industry has suggested that it could genetically engineer crops to use nitrogen fertilizer more efficiently. But a recent UCS report, *No Sure Fix*, found that this technology has yet to produce any nitrogen-efficient crops, and the prospects of it happening in the foreseeable future are uncertain.

Cover crops such as rye (left) and hairy vetch (right) help improve soil quality and prevent erosion on fields when crops for harvest and sale—“cash” crops—are not growing. When plowed under, cover crops provide nutrients for cash crops, allowing farmers to reduce or even eliminate chemical fertilizer use.



By contrast, advanced forms of traditional breeding *have* produced crops that are more nitrogen efficient, and we also found significant evidence indicating that cover crops can greatly reduce nitrogen pollution. For example, in experiments in which cash crops fertilized with synthetic nitrogen were rotated with non-leguminous cover crops, the cover crop reduced nitrogen leaching by an average of 70 percent, without reducing cash crop yields. When cash crops were rotated with leguminous cover crops and no synthetic nitrogen fertilizer was added, the cover crop reduced leaching by 40 percent. Though cash crop yields fell an average of 7 to 10 percent in these cases, the benefits of building soil quality could outweigh the loss in yield.

Maximizing the Benefits

In addition to reducing fertilizer use and nitrogen pollution, cover crops can play an important role in reducing global warming pollution. As the crops grow, they remove heat-trapping carbon dioxide from the atmosphere; when plowed under, the carbon in the plant is transferred into the soil. Non-leguminous cover crops such as rye and winter wheat are particularly good at storing carbon because they typically produce more biomass, or plant matter, than legumes. (More biomass also means more organic matter will be returned to the soil before cash crops are planted.)

An ideal cover crop system would provide the benefits of both legumes and non-legumes. One multi-year study found that hairy vetch and rye (a legume and non-legume, respectively) grown together yielded greater biomass and greater carbon and nitrogen content compared with either one grown alone. Yields and nitrogen uptake of some subsequent cash crops were also greater with this cover crop combination. Researchers are also looking at other legume/non-legume pairings. For

A Bacterium's-Eye View of Cover Crops

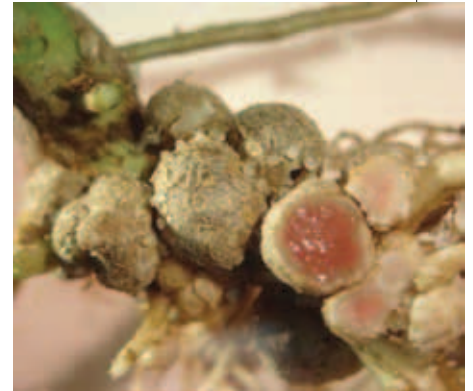
Underground, nature's tiny nitrogen factories are at work.

Producing fertilizer with high nitrogen content requires an extremely energy-intensive industrial process—at least it does if you're human. Certain soil-dwelling bacteria, on the other hand, can "fix" nitrogen (converting nitrogen gas in the atmosphere into ammonia, a form usable by plants) all by themselves. And soil bacteria known as rhizobia have evolved to fix large quantities of nitrogen by working in partnership with leguminous plants during the growing season.

The process begins when legumes release chemicals that stimulate the growth of rhizobia living in the soil around the plant roots. The bacteria

then attach to the plant's root hairs, which secrete compounds called flavonoids that activate "nod" genes in the bacteria. This, in turn, causes the rhizobia to excrete chemicals that curl the plant's root hairs, allowing the bacteria to invade the plant and penetrate its root cells.

The rapidly reproducing rhizobia induce the root cells to multiply, forming nodules that become visible to the naked eye within days. Each root nodule contains thousands of rhizobia that produce nitrogenase, an enzyme that catalyzes the transformation of nitrogen gas into ammonia that the plant uses to grow. Once the legume is plowed under, its organic matter and stored nitrogen become rich fodder for the cash crop planted in its wake.



Rhizobia-rich nodules on the root of a leguminous plant.

example, cover crops in the *Brassica* family (e.g., mustard, radish) are deep-rooted and therefore useful for breaking up hard soils; combined with legumes, they might prove beneficial in soils that are both nitrogen-deficient and heavily compacted.

Cover crops do have limitations, and additional research is needed to maximize their potential for farmers. For example, cover crop growth depends on the weather; low rainfall or cold autumn temperatures can reduce their growth—and thus their benefits. And farmers will need incentives and support to take on the seed and labor costs involved with growing them. Still, cover crops represent a major

underutilized opportunity to reduce nitrogen pollution, combat global warming, and build healthy, productive soils that will be good for American farmers and consumers alike.

Karen Perry Stillerman is a senior analyst in the Food and Environment Program.



Learn more about solutions for reducing nitrogen pollution on the UCS website at www.ucsusa.org/nosurefix.

Parents Who Think Big

“My generation has inherited a multitude of environmental, social, and political problems,” says Michael Mills, a member of the UCS Henry Kendall Society, “and I don’t want my children to inherit those same problems and more. I want to be a part of the solution.”

Michael and his family have been changing their lifestyle to minimize their environmental impact, and are deeply committed to supporting UCS. As he explains, “The degree of change needed

Michael and Leslie see their support for UCS as a measure of insurance on the cleaner, safer world they hope to leave for their children.

is enormous. The problems won’t be solved by personal choices alone.” UCS, in Michael’s words, has the influence to deliver the “game-changing legislation” needed to address these problems.

Changes Begin at Home

Michael appreciates the practical, science-based approach UCS takes to both public policy and consumer advice, including our book *The Consumer’s Guide to Effective Environmental Choices*, which helped him prioritize the lifestyle changes that will have the greatest impact. He learned, for example, that he didn’t need to worry about using paper bags versus plastic when the kind of car his family was driving made a much bigger difference. They now drive a hybrid model.

After learning about the environmental impact of their food choices, the family also changed the way they eat, reducing their consumption of meat,



growing many of their own vegetables and herbs, and buying the rest of their produce from a local CSA (community-supported agriculture) program. Leslie Mills blogs about cooking healthy food that her two daughters will enjoy, which isn’t always easy.

Nevertheless, she and Michael believe their new lifestyle will set a responsible example for their children. And they see their support for UCS as a measure of insurance on the cleaner, safer world they hope to leave their children.

Q: What’s a charitable gift annuity?

A: It’s a simple way to make a significant gift to UCS and get income back.

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For more information on charitable gift annuities, including gift calculators and other planning tips and tools, visit the UCS website or contact Adam Kessler at (800) 666-8276 or akessler@ucsusa.org.



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