

climate choices

how should we meet the challenges of a warming planet?

ENVIRONMENT &
SOCIETY SERIES
 naaee



About Forums

CLIMATE CHANGE IS NOT ONLY AN ENVIRONMENTAL PROBLEM. It is also a public-health issue, a threat to national security, and an economic challenge of considerable magnitude. Only recently has the public debate shifted away from weighing the evidence to asking what we should do about our changing climate and the effects that are beginning to be felt. Deliberative forums on this issue may not be easy. It may be helpful to remind participants that the objective of these forums is to begin to work through the tensions between the various things we hold most valuable.

In productive deliberation, people examine the advantages and disadvantages of different options for addressing a difficult public problem, weighing these against the things they hold deeply valuable.

The framework in this issue guide encompasses several options and provides an alternative means for moving forward to avoid polarizing rhetoric. Each option is rooted in a shared concern, proposes a distinct strategy for addressing the problem, and includes roles for citizens to play. Equally important, each option presents the drawbacks inherent in each action. Highlighting these drawbacks allows people to see the trade-offs that they need to consider in pursuing any action. It is these drawbacks, in large part, that make coming to shared judgment so difficult—but ultimately, so productive.

One effective way to hold deliberative forums on this issue:

Ask people to describe how climate change is affecting them, their families, or friends—or what worries them about it. Many are likely to mention the concerns identified in the framework.

Consider each option one at a time, using the actions and drawbacks as examples to illustrate what each option entails.

Review the conversation as a group, identifying any areas of common ground as well as issues that still must be worked through. The goal of this issue guide is to assist people in moving from initial reactions to more reflective judgment. That requires serious deliberation, or weighing options for action against the things people hold valuable.

About this Issue Guide

Environment and Society Series

This issue guide was prepared for the National Issues Forums Institute in collaboration with the Kettering Foundation and the North American Association for Environmental Education. The Environment and Society Series is designed to promote meaningful, productive deliberation, convened locally and online, about difficult issues that affect the environment and communities. For more information see www.naaee.org/eif. For deliberative forum guides on other environmental issues, see www.nifi.org.

The National Issues Forums Institute

National Issues Forums Institute (NIFI) is a nonprofit, nonpartisan organization that promotes public deliberation and coordinates the activities of the National Issues Forums network. It publishes the issue guides and other materials used by local forum groups, encourages collaboration among forum sponsors, and shares information about current activities in the network. Civic and educational organizations in the NIF network use NIF issue guides in locally initiated forums convened each year in hundreds of communities. www.nifi.org.

The North American Association for Environmental Education

For more than four decades, NAAEE has been a leader in promoting excellence in environmental education throughout North America. Its mission is to accelerate environmental literacy and civic engagement through the power of education. NAAEE is the only membership organization dedicated to strengthening the field of environmental education and increasing the visibility and effectiveness of the profession. NAAEE has members in more than 30 countries, including 54 state, provincial, and regional affiliate organizations in the United States, Canada, and Mexico. www.naaee.org

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Founded in 1927, the Kettering Foundation of Dayton, Ohio (with offices in Washington, D.C., and New York City), is a nonprofit, nonpartisan research institute that studies the public's role in democracy. It provides issue guides and other research for the National Issues Forums. For information about the Kettering Foundation, please visit www.kettering.org or contact the foundation at 200 Commons Road, Dayton, Ohio 45459.

introduction

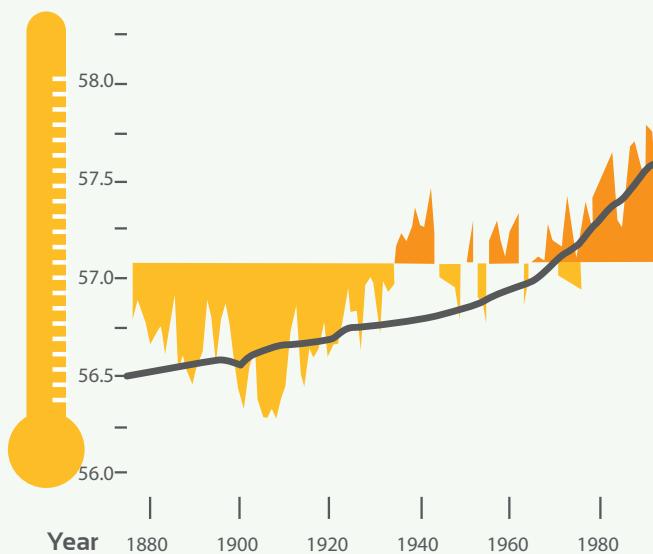
All around is evidence that the climate is changing. Summers are starting earlier and lasting longer. Heat waves are becoming more frequent and intense. Dry regions are getting drier and wet regions are seeing heavier rains. Record cold and snowfalls blanket some parts of the country, while record fires ravage forests across the West.

The effects are being felt across many parts of the United States. Farmworkers in California's Central Valley, snow-weary New England business owners, crab fishermen in Alaska, and cattle ranchers across the Great Plains have all seen uncommon and extreme weather. Occasional odd weather and weather cycles are nothing unusual.

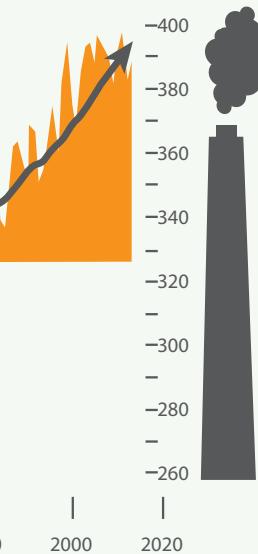
But the more extreme and unpredictable weather being experienced around the world points to dramatic changes in climate—the conditions that take place over years, decades, and longer.

Climate disruptions have some people worried about their health, their children, their homes, their livelihoods, their communities, and even their personal safety. They wonder about the future of the natural areas they enjoy and the wild animals and plants that live there. In addition, there are growing concerns about our national security and how climate change might affect scarce resources around the planet and increase global tensions.

GLOBAL TEMPERATURE (°F)



CO₂ CONCENTRATION (PPM)



GLOBAL TEMPERATURES RISE as Concentration of CO₂ in the Atmosphere Increases

The shaded areas on this graph show average annual temperatures starting in 1880. The chart shows temperatures both above (orange) and below (gold) the long-term average. The bold line shows the concentration of CO₂ in the atmosphere. This graph shows that average temperatures have been rising as CO₂ has become more concentrated in the atmosphere. (*National Climate Assessment, Global Change Information System, 2014*)

what's behind the changing climate?

These climate changes are driven by the buildup of heat-trapping “greenhouse gases” in the atmosphere. These gases include carbon dioxide (CO₂), methane, and nitrous oxide. There is now more CO₂ in the atmosphere than during any time in the last 800,000 years. Since the 1970s, the earth’s temperature has been rising more and more rapidly. This warming is throwing the systems that regulate heat and climate—such as oceans, soils, and forests—out of balance.

Most researchers expect the effects of climate change to intensify over the next 10 to 20 years and beyond. In large part, this is because many everyday activities add to the problem. It may be easy to connect

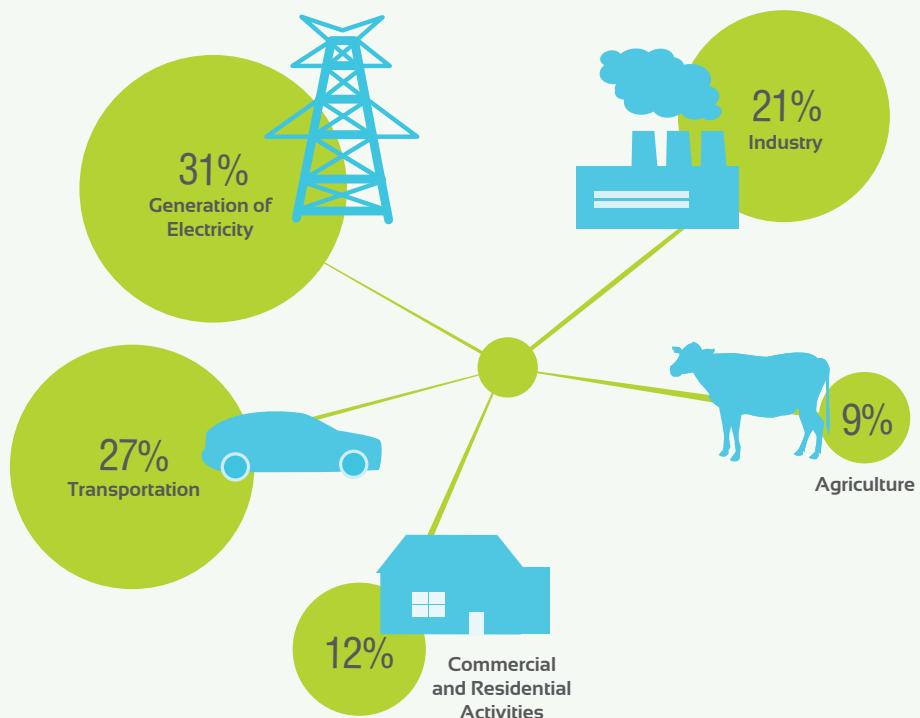
some activities like driving or flying with CO₂ emissions and climate change. But the effects of other daily decisions—like the foods we eat, the plastic packaging we use, or whether we recycle our glass bottles—also add up. These are multiplied significantly when emissions from industry, buildings, and commercial activities are included.

shifting the momentum

Most of the energy we use today is from fossil fuels—coal, oil, and natural gas. These three fuels account for most of the CO₂ emissions that human activities add to the atmosphere. Every year we add more, faster than natural processes can absorb carbon back into the environment. And that is only part of the problem. Other human accelerators of

SOURCES OF GREENHOUSE GAS EMISSIONS

Greenhouse gases, such as carbon dioxide and methane, trap heat and make the planet warmer. These occur naturally, but human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. This dramatic increase corresponds with warming average temperatures around the world. (US Environmental Protection Agency, Sources of Greenhouse Gas Emissions, 2013)



climate change include methane gas from sources like agriculture, mining, and landfills.

Earth has experienced climate change in the past—usually over thousands or millions of years. Today, the changes are measured in decades, even years. If we continue our current rate of adding carbon dioxide and other heat-trapping gases to the atmosphere, the warming of the planet could send us into uncharted territory, like nothing we have experienced in human history.

Even if we get emissions under control soon, we will be living with the effects of climate change for decades. Climate scientists agree that simply stabilizing emissions won't be enough to avoid potentially unmanageable impacts, and that significant reductions will be needed.

a wide range of impacts

Climate change is a complex and interconnected global issue, not simply an environmental problem. It is a wide-ranging economic problem, a threat to national security, a deepening public-health issue, a question of social justice, and a challenge for international relationships.

If the warming of the planet continues at its current rate, key industries like agriculture, insurance, fishing, and tourism would be hard hit, and property and infrastructure losses due to fires, droughts, storms, floods, and rising sea levels could be immense. Some areas may also see benefits, such as a longer growing season or faster forest growth, related to changes in climate.

A 2014 Pentagon report noted that climate-change impacts, including shortages of food, water, and power, damaged infrastructure, disease, and mass migrations are “threat multipliers.” The resulting instability could undermine governments and create fertile ground for terrorist and extremist organizations, as prolonged drought and widespread food shortages are already doing in Nigeria, Mali, and other countries in Africa’s Sahel region. In the United States, the Pentagon projects greater need for military intervention to deal with natural disasters.

Some medical professionals say that an increase in childhood asthma, infectious diseases, and heat-induced heart attacks can be linked to climate change and its effects, such as poor air quality, more common extreme weather events, and extensive wildfires. Expanded ranges and longer active seasons may make diseases spread by ticks, mosquitoes, and other pests more common. Adapting to new and different conditions—including hotter summers and colder winters—is likely to be most challenging for people who are elderly, very young, sick, or poor.

a framework for deliberation

The American people are still divided about some aspects of the climate-change issue, but there is growing agreement that action is needed. “An overwhelming majority of the American public, including half of Republicans, support government action to curb global warming,” the *New York Times* reported, citing its January 2015 poll conducted with Stanford University and the nonpartisan group Resources for the Future.

This issue guide is designed as a starting point for dialogue. It asks, “What should we do about our changing climate and the effects that are beginning to be felt across the country and around the world?”

The guide presents three options for addressing climate change that are based on the views and concerns of people from across the country. Each is built on a framework of supporting ideas and information drawn from climate reports, academic studies, public-policy proposals, and other sources. Climate change, and how we choose to respond to it, puts these essential values into tension with each other.

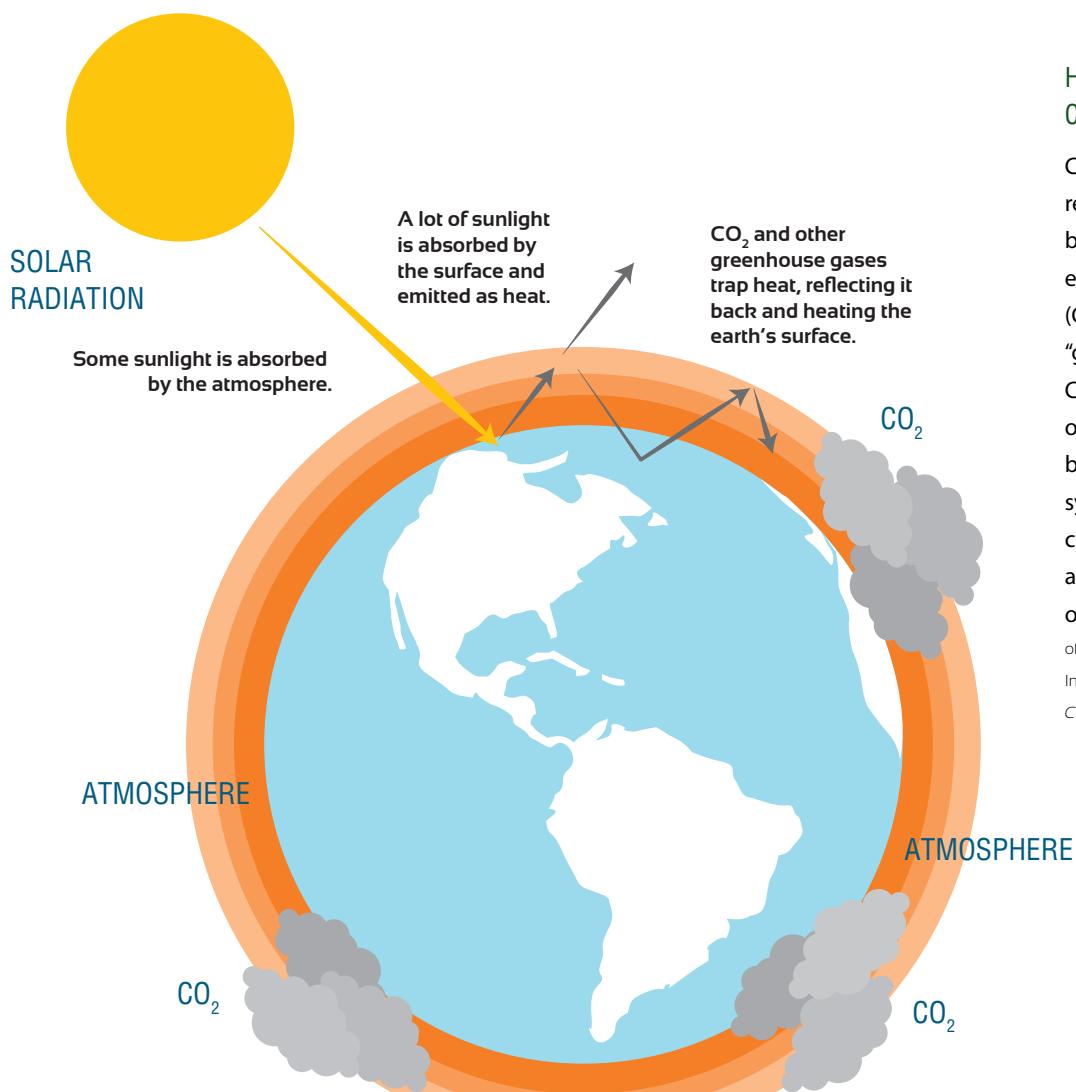
- The first option says we need to dramatically reduce carbon emissions at the local, national, and international levels because moving swiftly to tackle climate change at its source is the only way to avoid catastrophic effects.

- The second option holds that our first priority must be to respond and adapt to the effects of climate change that are already being felt across the country and around the world, because that is the best way to protect our society and the most vulnerable among us.

- The third option makes the case that our best response is to support the search for innovative solutions to climate change, because directing American resources and ingenuity toward societal good has met past challenges and enabled us to have our modern way of life.

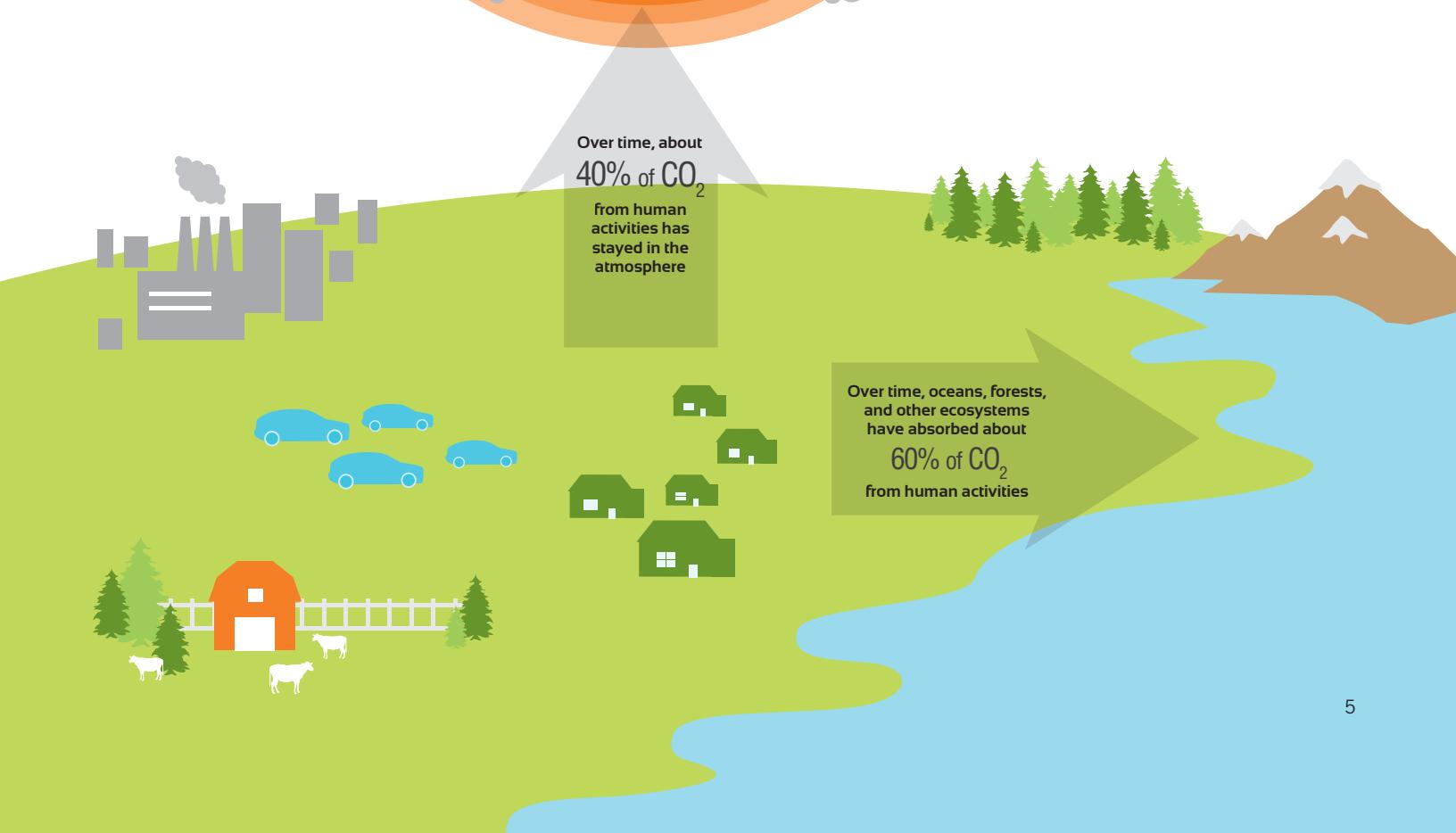
These options offer a framework for deliberations that tackle tough questions: What should we do? What are the risks and potential trade-offs? What steps can we support and what might we be willing to give up? Where do we share concerns and priorities that point the way toward more effective action?

Climate change, and how we choose to respond to it, puts our essential concerns and values into tension with each other.



HOW CLIMATE CHANGE WORKS

Climate change is largely the result of global warming caused by rising levels of certain gases, especially carbon dioxide (CO₂), in the atmosphere. These "greenhouse gases," including CO₂, methane, and nitrous oxide, act like a heat-trapping blanket. As the earth warms, the systems that regulate heat and climate—such as oceans, soils, and forests—are thrown out of balance. (Data on distribution of CO₂ from human activities from International Panel on Climate Change, *Climate Change 2013*.)



option 1 : sharply reduce carbon emissions

This option says we can no longer rely on piecemeal, voluntary efforts to reduce carbon emissions. The only way to protect ourselves and the planet is to tackle climate change at its source by taking coordinated, aggressive action to reduce the CO₂ we put into the atmosphere—enforced by strict laws and regulations, and supported by significant investment. If we don't make averting further climate change our top priority, warming of the land and oceans will accelerate, increasing the frequency of droughts, fires, floods, and other extreme weather events, and damaging the environment for generations to come.

Further, America needs to be a strong leader in international efforts to cut emissions.

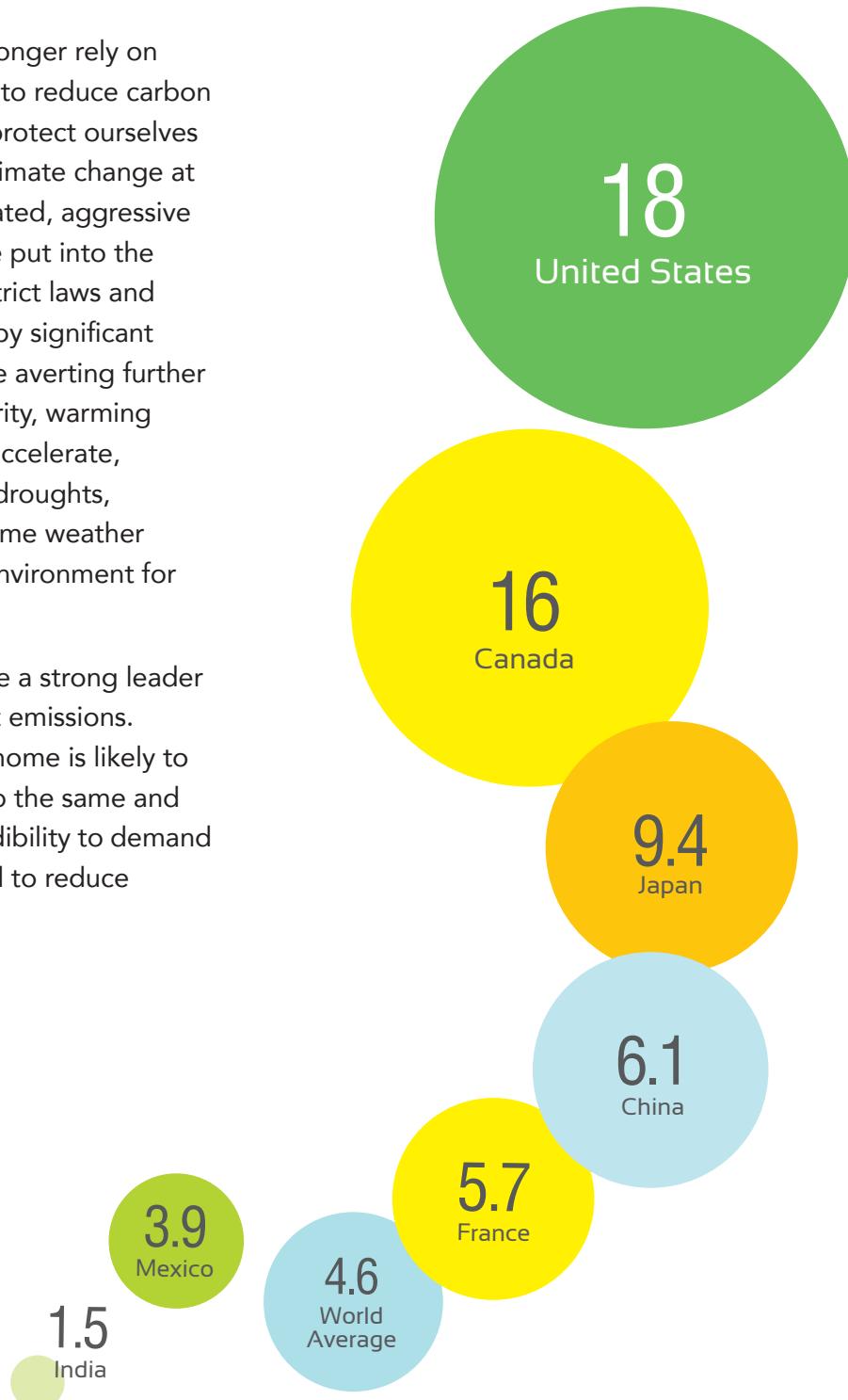
Taking aggressive action at home is likely to influence other nations to do the same and will give our country the credibility to demand the strong measures needed to reduce global emissions.

PER CAPITA CO₂ EMISSIONS IN SELECTED COUNTRIES

Metric tons per person per year from burning fossil fuels

The United States emits more CO₂ per person than most other countries in the world.

(US Energy Information Agency, International Energy Statistics, 2011)



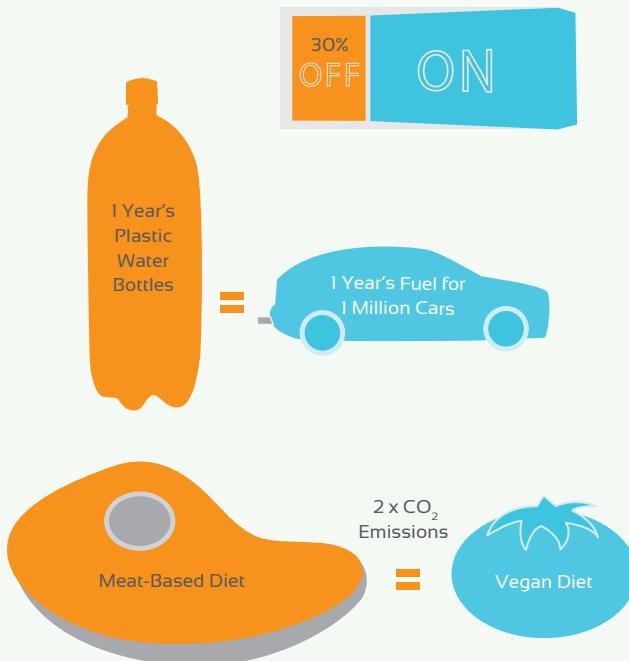
efficiency and conservation

Perhaps the most obvious approach to cutting emissions is to reduce our energy consumption. The advantage of this strategy is that we don't have to wait for our leaders to get the ball rolling. There are carbon-cutting steps each of us can take to reduce our overall CO₂ emissions. This option proposes that Americans be strongly encouraged and even required to take such actions.

If Americans were required to better insulate their homes, switch to fluorescent or LED bulbs, use clotheslines instead of dryers, grow more of their own food, and cut down on their air travel—to name just a few energy-saving actions each person could take—that would amount to a sizable cutback of our combined CO₂ emissions.

In addition, we should encourage, if not require, companies and power utilities to reduce emissions. For example, requiring auto manufacturers to dramatically increase the fuel economy of their new cars and trucks, or mandating that coal-fired power plants raise efficiencies would cut carbon emissions significantly.

Making it easier for families to get by with one car instead of two—through increased telecommuting or better biking facilities—could have an even bigger impact. How much a vehicle is driven is more important than fuel economy in determining total emissions. Reducing the need to drive could also reduce the total number of cars produced, decreasing the carbon impact of automobile production.



DAILY IMPACTS ADD UP

Nearly a third of consumer electronics' electricity use happens when the equipment is off, sleeping, or idle.

(Urban et al., *Energy Consumption of Consumer Electronics in US Homes in 2013*, Fraunhofer USA Center for Sustainable Energy Systems, June 2014)

Making a year's worth of plastic water bottles for Americans uses enough energy to fuel a million cars and light trucks for a year. (*Bottled Water and Energy* fact sheet, Pacific Institute, 2007)

An Oxford University study found that, on average, production, transportation, storage, cooking, and waste from meat-eaters' diets produce twice the greenhouse gas emissions of vegan diets. (Scarborough et al.,

"Dietary Greenhouse Gas Emissions of Meat-Eaters, Fish-Eaters, Vegetarians and Vegans in the UK," *Climate Change*, 2014)

transitioning to a low-carbon economy

Reducing our energy consumption is an important step, but any long-term strategy will require that we transition away from carbon-based energy sources altogether. One way to do that is to ramp up our use of nuclear power, a source of energy that produces few, if any, CO₂ emissions but poses concerns about safety and radioactive waste disposal.

Some see natural gas as a promising energy source that could be harnessed until renewable energy is fully developed. While it produces only about half the emissions of coal or oil, burning natural gas still releases CO₂ into the atmosphere. The process of hydraulic fracturing (or “fracking”), often used to extract natural gas from the ground, releases the greenhouse gas methane into the atmosphere. There are also concerns about groundwater contamination and earthquakes.

Reducing our carbon footprint will require that we meet more of our energy needs from renewable energy sources, such as

hydroelectric, wind, geothermal, and solar, which don’t directly contribute a single molecule of CO₂.

Take solar power, for example. Enough raw energy reaches Earth from the sun in a single hour to equal all of the energy used by the entire world in a year. The challenge is finding ways to harness that energy in cost-effective ways and at a large scale—something we have not been able to do until relatively recently.

By 2017, Georgetown, a small city in Central Texas, plans to supply all of its electricity needs with wind and solar power. It is the first municipally owned utility in Texas to switch off traditional energy sources altogether. More and more cities across the country are striving to do the same. The goal is becoming more realistic as the cost of renewable energy continues to drop. For Georgetown, the switch will protect air quality, curb water use, and most important to the city, ensure a reliably low-cost electricity supply.

Solar professionals, job trainees, and volunteers work together to install solar systems in low-income communities through programs like Grid Alternatives, a nonprofit that makes clean, local energy and energy cost savings available to people who could otherwise not afford it. Hands-on job training helps prepare residents of those communities for jobs in the solar industry.

(© Grid Alternatives)



In 2014, renewable sources accounted for about 13 percent of the electrical power generated in the United States. A study by the Department of Energy's National Renewable Energy Laboratory shows that the United States could generate most of its electricity—80 percent—from renewable energy by 2050, relying solely on available technologies, including wind turbines, solar photovoltaics, concentrated solar power, biofuels from algae and other sources, geothermal, and hydropower. This option holds that we need to take much stronger action to make these things a reality.

what we could do

For these efforts to be effective, they need to be part of coordinated plans and policies. Here is a look at a handful of practical strategies for curbing our CO₂ emissions, along with some of the potential drawbacks associated with each.

Create a federal low-emission standard. A national low-emission standard (sometimes referred to as a renewable-energy standard) would require that each state meet a certain percentage of its energy needs from non-carbon sources, such as wind, solar, hydropower, and nuclear. Such a standard—similar to those already in place in some states and other countries—would speed the transition away from fossil fuels while at the same time cutting our carbon emissions.

But such a standard could unfairly displace workers and harm communities in some states—especially those that rely heavily on the coal, oil, and gas industries—while having

little or no impact on others that already rely more heavily on renewable sources. And “clean,” low-carbon energy sources have other environmental and health downsides, so we may be trading one basket of problems for another.

Place strict limits on allowable CO₂ emissions, but make them transferable.

Also known as “cap and trade,” this would create incentives for companies and utilities to reduce their emissions by putting a tradable limit on the amount of allowable emissions. Such a system proved successful in 1995 when Congress put a limit on the emissions that cause acid rain.

But a cap-and-trade system could make it seem acceptable to pollute as long as a company can afford to pay, and does nothing to help communities near polluting facilities address their health and safety concerns.

Impose a carbon fee on fossil-fuel suppliers.

A carbon fee would raise the cost of fossil fuels, encouraging companies and individuals to shift toward more affordable choices that emit less CO₂. And the proceeds from this fee could be returned as a dividend that would be evenly distributed among taxpayers, reinjecting the funds into the economy.

But a carbon fee might unfairly affect poor Americans by raising the costs of basic necessities like driving a car, heating a home, and buying food. Even with the dividend, there would be a lag time between paying these increased costs and receiving the dividend payment.

Mandate the use of alternatives to driving cars, trucks, and other vehicles that burn fossil fuels. We could ban cars in some areas and require electric vehicles in the public transportation sector. We could also redirect federal highway funds toward expanding bike lanes, and change zoning ordinances to create pedestrian-friendly neighborhoods and shopping districts.

But banning cars and trucks is intrusive and would limit mobility in some areas. It could take years, or even decades, to make these changes when we need to make sharp emission cuts today. And, depending on the power source, electric vehicles still have environmental impacts and contribute to climate change.

Dramatically and rapidly reduce personal and household power consumption.

We could target emissions generated by household energy use by requiring dramatic reductions. Forcing simple actions, such as home weatherization, installing efficient appliances, using low rolling-resistance tires, and driving less, would dramatically reduce emissions.

But changes like these will put extra strain on low- and moderate-income communities and families, which have few resources to choose more climate-friendly behaviors. And subsidizing these changes could burden taxpayers and take resources away from the kinds of support that will help less-wealthy Americans improve their lives.

According to this option, the only way to protect ourselves and the planet is to tackle climate change at its source by taking coordinated, aggressive action to reduce the CO₂ we put into the atmosphere.

option 2 : prepare and protect our communities

When heavy rains fall, many residents of Miami find themselves ankle-deep in a mixture of rain, salt water, and waste surging up from the sewers. Farther north, more than 100 people died as a direct result of Super-storm Sandy, which also destroyed hundreds of thousands of homes and forced tens of thousands of people into shelters.

In Norfolk, Virginia, at high tide, the water now laps at the top of a concrete seawall built a century ago to protect the city. It frequently spills over, flooding the promenade and streets along the waterfront. The Unitarian Church of Norfolk can no longer afford the high cost of flood insurance. "We don't like being the poster child for climate change," minister Jennifer Slade told the *Washington Post*, adding that the congregation has no choice but to relocate. "I don't know many churches that have to put the tide chart on their website [so people know whether they can get to church]."

A 2013 study shows eight US cities among the world's top 20 for potential losses to buildings, transportation, utilities, and personal property from storm surges and rising sea levels. They include Miami, New York City, New Orleans, Boston, Philadelphia, and Baltimore.

In other parts of the country, the effects of climate change are different, but no less severe. California and much of the western United States have been parched by drought and seared by wildfires in recent years. Extreme weather has destroyed homes and ruined lives, and conditions continue to get hotter and drier. Wildfires are bigger, burning longer, and taking more lives than ever before. Federal wildfire appropriations have tripled to \$3 billion since the 1990s. Another \$1-2 billion is spent by states on wildfire protection. A recent NASA study projects that, if the current rate of climate change is not reduced, the US Southwest and Central Plains could face mega-droughts by the last half of this century, potentially lasting 30-35 years.

According to this option, preparing for and coping with changing conditions must be our top priority. We should work together now to secure our communities and strengthen our resilience in the face of climate-related impacts. That includes protecting our infrastructure—roads, bridges, and shorelines—and ensuring that the most vulnerable members of society have the support they need to adapt to the effects of a warming planet.



- | | | |
|--|---|--|
|  Heat waves, poor air quality, health-related problems |  Reductions or changes in wildlife habitat |  Economic disruptions and infrastructure problems |
|  Declines in farm, livestock, and/or fisheries production |  Lower snowpack, deeper droughts |  Declines in hydropower production |
|  Increased competition for water |  Worsening wildfires |  Increased water-borne, pest-transmitted, or shellfish-borne diseases |
|  Rising sea levels, flooding, heavier storm surges, coastal property damage, and habitat loss |  Heavy rains, alternating with longer, deeper droughts | |

CLIMATE CHANGE THREATS BY REGION

Climate change poses threats to every part of the country. This map shows the impacts for which each region will need to prepare. (National Climate Assessment, Global Change Information System, 2014)

assessing the risks

How do we best prepare to deal with the risks posed by climate change? The risks include not just property loss but also threats to people who are vulnerable, including those who are poor, elderly, or sick. The 2014 *National Climate Assessment* identifies a range of likely impacts for which our communities need to prepare.

- Storm surges, flooding, and rising sea levels pose serious risks for coastal communities. These include harm to individuals, disrupted livelihoods, and loss of infrastructure and personal property.
- Extreme weather events threaten basic infrastructure networks and critical services like electricity, water supply, and health and emergency services.
- Hotter temperatures increase the risk of heart attacks and other health problems, especially among vulnerable urban populations and those working outdoors.
- Heat waves, droughts, flooding, and heavy rains increase the likelihood of food shortages, especially among poorer populations.
- Melting glaciers and snowpack pose risks to communities that depend on inland water ecosystems. Threats include water shortages, power outages, and disrupted local economies.

Across the country, some cities and towns are already at work preparing for these risks. Others have plans on the drawing board. In New Orleans, for example, the city planning commission is working with local universities and neighborhood organizations to relocate family homes in low-lying areas to higher ground. They are also exploring ways to convert unused lands into green parks and urban farms that create natural flood control systems.

In some cities, sea barriers and improved drainage systems are being created to lower the risk of flooding. Across the corn belt and in California's Central Valley, farmers are introducing drought-resistant crops and changing their planting times in response to longer, drier, and hotter growing seasons. And architects across the country are designing buildings that reduce the risk of flooding when it rains and stay cool during the hot summer months.

While there are still uncertainties regarding the exact nature and magnitude of climate effects, "mobilizing now to increase the nation's adaptive capacity can be viewed as an insurance policy against an uncertain future," according to a report by the nonpartisan National Research Council. According to this option, communities should take a cue from insurance companies that are already refusing coverage for homes and buildings vulnerable to sea-level rise, and from major corporations and government arms, such as the military, which incorporate climate-change adaptation into their long-term plans.

taking care of the most vulnerable

Public-health experts point to several groups that will have the hardest time dealing with the effects of climate change. These include people who are very old or very young, have chronic or acute health problems, are homeless or poor, or who work outdoors. For these people, problems like worsening air pollution, hotter summers, colder winters, severe storms, and widespread infectious diseases could easily become life threatening. And people in these vulnerable groups often cannot afford to miss work to deal with personal or family health issues.

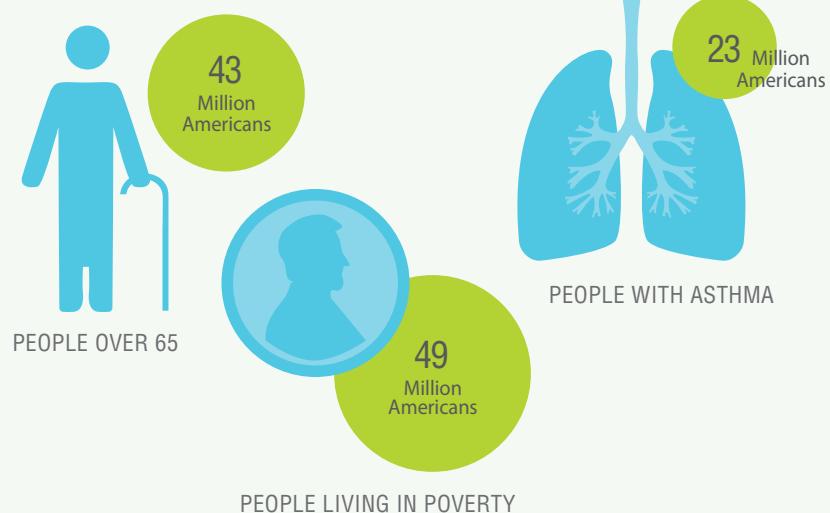
These vulnerable populations will require special support and care. This option holds there is something for everyone to do. Employer and community programs and family activities that promote health and fitness should be targeted to reduce risk factors, such as obesity, asthma, and

age- and lifestyle-related health problems. Government agencies and nonprofits should step up efforts to improve weatherization and upgrade heating and cooling systems in low-income housing, and provide energy assistance to pay for increased power costs during heat waves, extreme cold, and storms. Companies that employ outdoor workers should provide adequate protection against weather extremes, and adjust working hours to avoid dangerous heat or cold.

Even with strong preventive measures, some people will still require special assistance to stay healthy—and even survive—through the effects of climate change. Public-assistance and health-care providers, churches, community groups, employers, and families all need to plan ahead to meet these needs. Disaster-preparedness plans will need to be modified and emergency and ongoing health services expanded to meet the new challenges of climate change.

PARTS OF THE POPULATION VULNERABLE TO CLIMATE CHANGE

Large—and growing—parts of the United States population are especially vulnerable to the effects of climate change. (Age and poverty data, United States Census Bureau, 2012; asthma data, Centers for Disease Control and Prevention, 2013)



what we could do

This option holds that our first responsibility is to prepare and respond to damage that we know is likely. Here are a few actions that we might take to do so. All of these steps would reduce the risks associated with climate change, but each of them has trade-offs.

Protect against the effects of extreme weather and rising sea levels. We should safeguard our cities and communities from storms, fires, droughts, and other extreme weather events by investing in more resilient infrastructure. Examples include upgrading storm-water systems, building levees and seawalls, installing emergency water-supply systems, and building roads and transit above projected flood levels.

But such major public programs will be disruptive, and will change the landscape of many communities. Since many of these are large projects that need to be started before we know exactly how damaging the effects of climate change will be in specific places, strengthening infrastructure could be an intensive and environmentally costly undertaking, without guarantee of adequate protection.

Expand health and social services. This would include ensuring that people have access to the care, treatment, and assistance—such as cooling centers, emergency food and housing, health-care treatment, and psychological counseling—they will need to deal with illness, prolonged heat stress, hunger, homelessness, and other personal and family issues caused by climate change.

But charities, social-services providers, local governments, and other organizations might not have sufficient resources to care for people affected by damaging storms and other climate-related impacts. At some point, the effects of climate change will become so bad that we will not be able to protect everyone.

Keep people from living and building in areas most vulnerable to climate change hazards. We could employ land-use regulations, zoning, building codes, and insurance rules to protect communities from property damage and natural disasters.

But these new regulations will infringe on property rights and impose large economic burdens on some property owners, while enhancing the value of other properties.

According to this option, preparing for and coping with changing conditions must be our top priority. We should work together now to secure our communities and strengthen our resilience in the face of climate-related impacts.

Make our communities more self-sufficient. We could boost the ability of our communities to provide for their own basic needs. Small-scale power grids that can operate either independently or as part of a region's main electrical grid can be a life saver when extreme weather hits. A strong local agricultural base—including urban gardens and small-scale producers—can increase food security and reduce our carbon footprint by supplying organic, locally grown, locally produced food.

But self-sufficiency can be difficult and expensive to achieve. It also flies in the face of our accustomed ways of living and existing centralized infrastructure. Many parts of the country, for instance, do not produce sufficient quantities of food to meet the demand, especially in the winter, and food choices would be limited with only locally grown options.

Change farming. We could offer subsidies, technical support, and information to farmers to help them transition to foodcrops and farming methods capable of withstanding climate disruptions.

But this entails a change in farmers' ways of life. Furthermore, this kind of support, especially subsidies, could be unfair unless the government also steps in to help other industries affected by climate change, such as coal mining, fishing, and tourism.



Volunteers at the Earthworks Urban Farm in Detroit, Michigan, are part of a local food movement encouraged by recent city ordinances that promote urban agriculture. The city is home to more than 1,350 community gardens, plus farmers markets, food trucks, urban farms, and local food businesses.

(© Earthworks Urban Farm/Capuchin Soup Kitchen)

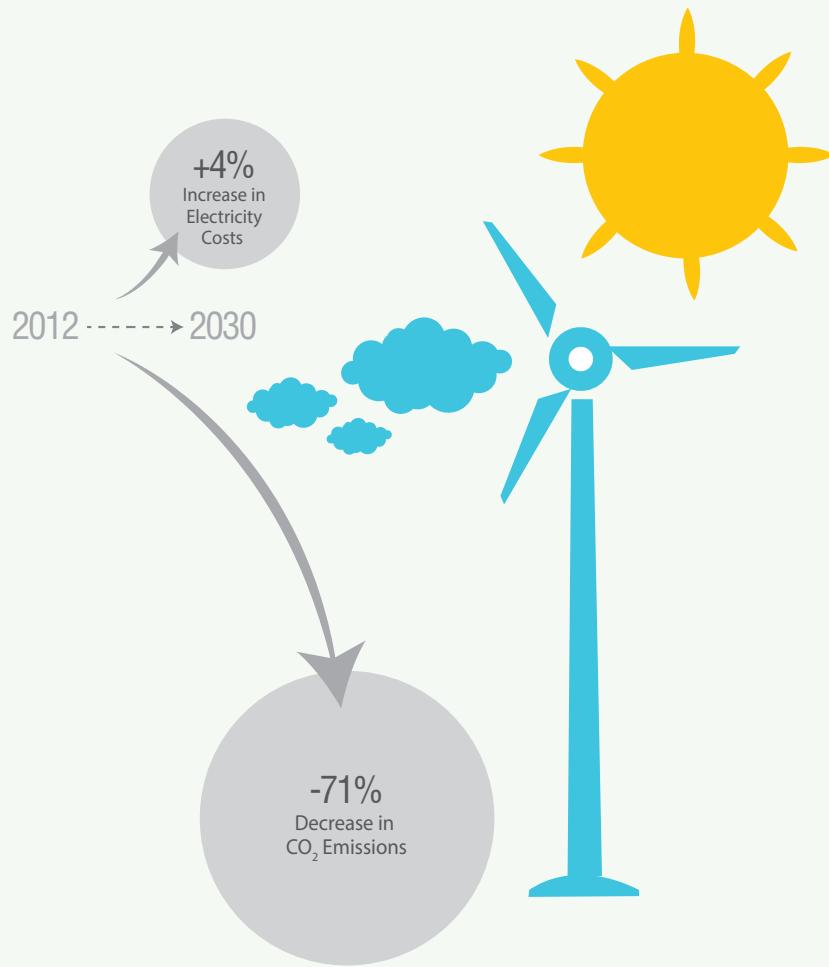
option 3 : accelerate innovation

Across the country and around the world, many private enterprises are already responding to climate change by seeing opportunity. Agricultural biotech companies Monsanto and Syngenta, for example, are poised to profit from newly patented drought-resistant crops. The water giant Veolia, which manages pipes and builds desalination plants, has expanded its operations to 74 countries on five continents. Lucid Energy, a startup in Portland, Oregon, generates electric power from the city's domestic water pipes.

Other companies are actively developing products that will appeal to environmentally aware customers. Tesla Motors' Model S, for example, was the first highway-capable electric car to reach the US market. General Motors is investing heavily in advanced battery technology and streamlining its production process to make electric vehicles more affordable. Between 2012 and 2014, sales of American-made electric cars and trucks more than doubled to 119,000 vehicles.

A FUTURE POWERED BY SOLAR AND WIND: 2030 Electricity Cost and CO₂ Emissions Compared to 2012

NOAA researchers used a sophisticated simulator to show that renewable energy can be employed on a large scale and at a reasonable cost in the United States. By 2030, a cost-optimized power system that emphasizes wind and solar, along with natural gas, hydroelectric, and nuclear power, could significantly cut CO₂ emissions from generating power with only a small increase in electricity costs. (MacDonald et al, "Future Cost-Competitive Electricity Systems and Their Impact on US CO₂ Emissions," *Nature Climate Change*, January 2016)



While climate change represents a serious long-term challenge, it also presents unique opportunities for ingenuity and innovation. This option says our best response to the problem is to promote American leadership in the search for creative solutions.

"The United States should realize this as a business opportunity," says physicist and former US Secretary of Energy Steven Chu, referring to climate change. "We have incredible intellectual capital in the United States. Why don't we say, 'We can go find the solutions, and, not only that, we can export them to the rest of the world.'"

clean energy and other innovations

Energy from the sun, wind, and other renewable sources is sometimes believed to be too expensive an option to employ on a wide scale, but in a growing number of states and cities, solar power is now just as cheap as conventional fossil fuel-based energy, and the cost is going down. During the first half of 2015, nearly 70 percent of all new power capacity in the US came from renewable sources.

Renewable energy is not only clean—it doesn't directly emit CO₂ into the atmosphere—but it could also serve as the backbone for a strong and sustainable 21st century US economy. Clean energy is already a burgeoning growth industry, adding jobs to the US economy.

Innovations that help reduce CO₂ emissions go beyond developing better renewable energy technologies. Driven by innovations in technology and financing, there is a nationwide move afoot to decentralize power generation by installing household solar- and wind-generation systems. The electric grid, which was once a one-way delivery system, now runs two ways, delivering power to homes and collecting and redistributing power from home power-generation systems.

Technologies like smart meters also allow utilities to collect more data about home energy use. Utilities pay "electricity consumer engagement companies," such as Opower, to use this information to help reduce power consumption. By showing people how much electricity they use and when they use it, "grading" their energy use compared to their neighbors, and offering individualized energy-saving advice, these companies combine information, behavioral science, and social pressure to change behavior.

investing in new technologies

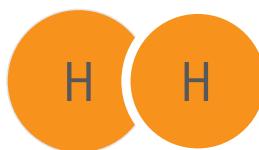
According to this option, it's only a matter of time before coal, gas, and oil are phased out. They will be replaced, much like the automobile replaced the horse and buggy a century ago or the way the modern smartphone combined the portable music player, alarm clock, camera, and GPS into a single small device. Acting quickly to bring new technologies to market will also help us stay competitive with other countries like Germany and China that are already investing heavily in clean energy.

If we want rapid development of hydrogen-powered trams that emit only water vapor, tires that generate electricity while driving, biofuels produced from renewable sources like algae, and other technologies that will help dramatically cut CO₂ emissions, the United States will also need to make significant public and private investment in research and development. This might include tax breaks and other subsidies, as well as grants for research and development of cutting-edge technologies.

This option holds that America should put all of its resources to work in pursuit of climate-friendly innovation. For example, our universities house a vast intellectual capacity that could be freed up to work in closer partnership on research initiatives developed and funded by private firms and nonprofit organizations. And promising new technologies for averting further climate change could be given preferential treatment that would make it quicker and easier to clear patent and other regulatory hurdles.

geoengineering

Another set of new technologies, collectively referred to as geoengineering, aims to modify Earth's climate to offset rising surface temperatures. They do this either by carbon dioxide reduction, which scrubs CO₂ from the atmosphere, or by solar radiation management, which reflects sunlight and heat back into space. Where strategies to reduce CO₂ emissions might show results over many decades, geoengineering aims to make a bigger difference faster.



A Chinese company developed a tram that runs on hydrogen and emits only water vapor.



Apps that identify and give directions to open parking spaces cut into CO₂ emissions from people looking for parking.



Biofuels made from algae can cut CO₂ emissions significantly compared to petroleum fuels.



"Ugly Produce" vendors cut down on CO₂ emissions from food waste by selling fruit and vegetables that are too small or misshapen to sell to grocers.

INNOVATIONS CUT CO₂ EMISSIONS

Businesses are finding opportunities to reduce CO₂ emissions and generate revenue in some unexpected places.

(Algae biofuels emissions from Liu et al., "Pilot-Scale Data Provide Enhanced Estimates of the Life Cycle Energy and Emissions Profile of Algae Biofuels Produced Via Hydrothermal Liquefaction," *Bioresource Technology*, November 2013)



Companies like Lucid Energy in Portland, Oregon, are generating revenue by producing power in less-polluting ways. Lucid has developed an in-pipe turbine that generates power from water moving through municipal and other large water systems. Many jobs in the “new” low-carbon energy economy use skills similar to those needed in current energy and manufacturing jobs. (Jennifer Newton, © Lucid Energy)

Some forms of carbon-dioxide reduction are low-tech and can be implemented today. These include planting trees, rebuilding over-grazed rangelands with perennial grasslands, using organic farming techniques that increase carbon in soils, and adding iron filings to the oceans to increase their ability to absorb CO₂. Others are more complex and costly, such as removing CO₂ from the atmosphere or “sequestering” it—capturing emissions from power plants before they escape into the atmosphere and then storing the CO₂ underground.

Solar-radiation management—a more controversial approach to geoengineering—attempts to reduce the amount of solar energy reaching the planet’s surface. Some proposals involve pumping sulfate particles into the atmosphere, mimicking major volcanic eruptions that have a cooling

effect on the planet. According to William Nordhaus in his book *The Climate Casino*, “climate scientists have calculated that reflecting about two percent of the solar energy reaching the planet’s surface could offset the warming effect of a doubling of CO₂.”

While climate change represents a serious long-term challenge, it also presents unique opportunities for ingenuity and innovation.

what we can do

As we look to the future, climate change represents a complex and pressing set of challenges. But it also presents unique opportunities. This option makes the case for seizing those opportunities—not just to tackle climate change, but to create jobs, increase American competitiveness, and bolster the US economy. Here are some of the practical steps we might take toward that end, along with potential drawbacks.

Incentivize climate-related innovation.

We could create incentives for companies advancing new solutions in energy storage and efficiency, water reclamation, mining waste and recycling, sustainable agriculture, and other technologies that would support an emerging clean-energy economy.

But this would put the government in a position of picking winners and losers, thus interfering in the private sector.

Invest in geoengineering. By strengthening research, testing, and large-scale development of geoengineering—scientific methods for modifying Earth’s climate—we could offset the effects of high levels of CO₂ in the atmosphere.

But few, if any, large-scale geoengineering tests have been performed to date. We don’t know what the outcomes might be, and they might backfire or have unintended consequences, such as damaging Earth’s protective ozone layer, causing weather disruptions, or worsening droughts.

Relax restrictions. We could ease patent and other regulatory processes so that businesses

can bring new “green” technologies to the market much more quickly.

But some harmful new technologies may slip through the cracks if we loosen our regulatory standards.

Strengthen the role of businesses and nongovernmental organizations in shaping research and development. We could promote social and technological innovation in tackling climate change by giving the private and civic sectors wider latitude to direct the research performed by American universities.

But this might give businesses and organizations undue influence over America’s academic institutions, enabling them to “buy” favorable research and undercutting the academy’s primary mission: to educate.

Use technological and social innovations to encourage individuals and households to lower fuel and power consumption and CO₂ emissions. We should share data from technologies like smart electric meters for homes and GPS-enabled communications systems in cars with consumers in ways that will encourage them to reduce their CO₂ emissions while also saving money. Using peer pressure and social networking could motivate people to change how much energy they use.

But collecting and sharing personal information raises concerns about privacy and data security. While well intentioned, this could be seen as manipulating personal behavior, and could open the door to “mob rule,” as the pressure to reduce emissions becomes more public.

climate choices

option summary: how should we meet the challenges of a warming planet?

We don't know just how much warmer the planet will get in coming years, nor exactly how this will upset the climate in different regions. Yet we can already see the effects of climate change across the United States. They include more frequent and intense heat waves, colder winters, stronger hurricanes, prolonged droughts, heavier rainfall, melting glaciers and snowpacks, ocean acidification, and rising sea levels.

The planet has experienced climate change in the past. But it usually played out over thousands or millions of years. Today the change is measured in decades, even years. If we continue to burn fossil fuels at our current rate, the heating of the planet could send us into uncharted territory, with effects that are impossible to predict, much less prepare for.

Climate change is not only an environmental problem. It is also a public-health issue, a threat to national security, and an economic challenge of considerable magnitude. For years, much of the public debate about climate change has focused on weighing the evidence. But now, the central question has become: What should we do about our changing climate and the effects that are beginning to be felt across the country and around the world?

What should we do? What are the options? What are the risks and potential trade-offs involved? If we pursue one course of action, we may not be able to pursue another. What steps can we support and what might we be willing to give up?

The following options present three ways to approach the problem, along with their potential trade-offs. These are not the only options for addressing climate change, but they capture a range of commonly held views, along with their drawbacks.

option 1: sharply reduce carbon emissions

We need to take aggressive action to reduce our energy consumption and other climate-changing behaviors. If we do not move swiftly to tackle the problem of climate change at its source, we risk catastrophic effects that we—and future generations—will not be able to handle. **BUT** this approach could limit our personal choices and freedom. And some people, communities, and businesses will be affected by the required changes more than others.

| Examples of What Could Be Done | Some Trade-Offs to Consider |
|---|---|
| Require that states meet a national low-emission standard (with a percentage of energy needs coming from renewable sources). | This could displace workers and harm communities that rely on fossil-fuel industries. So-called “clean” energy sources also carry environmental and health downsides. |
| Institute a carbon-credit (“cap-and-trade”) system that limits emissions. | Capping emissions over time and “trading” credits could leave communities without immediate help for health and safety concerns. |
| Charge fossil-fuel providers a carbon fee, which would encourage Americans to choose low-carbon, lower-cost alternatives. Dividends from the fees could be rebated to households. | A carbon fee would burden poor Americans by raising the costs of basic necessities, even if a rebate is later provided. |
| Require the use of electric vehicles, ban cars in some areas, and redirect highway funds to create bike lanes and pedestrian-friendly neighborhoods. | It could take decades to make these changes when we need to cut emissions immediately, and electric vehicles still have environmental impacts. |
| Require dramatic reductions in household energy use through weatherization, efficient appliances and tires, and reduced driving. | These changes could strain low- and moderate-income communities and families that are already struggling. |

option 2: prepare and protect our communities

This option says we should protect and prepare communities and businesses for the most likely effects of climate change. We need to work together now to strengthen our resilience in the face of climate-related impacts like flooding, drought, fire, health problems, and social unrest. BUT this approach does little to slow climate change, so we will have to accept greater environmental damage from climate change, including changes that we may not be able to manage. And some people and communities will need to make bigger changes and sacrifices than others.

Examples of What Could Be Done

Upgrade storm-water systems, build levees, install emergency water-supply systems, and build roads and transit above projected flood levels.

Ensure that people have access to care, treatment, and assistance in the face of prolonged heat stress, hunger, homelessness, and other issues.

Use zoning, building codes, relocation, and insurance rules to keep people from living and building in vulnerable areas.

Make communities more self-sufficient by building independent power grids and creating strong local agricultural production.

Offer subsidies and technical support to help farmers transition to crops and farming methods that can withstand climate disruptions.

Some Trade-Offs to Consider

This will change the landscape in many communities and does not guarantee adequate protection.

Local organizations might not be sufficient for caring for people impacted by climate-related events.

This would infringe on property rights and impose larger economic burdens on some property owners.

Local power grids may not be feasible, and many parts of the country can't produce enough food to meet the demand, especially in winter.

Subsidies to farmers could be seen as unfair by other industries affected by climate change.

option 3: accelerate innovation

We must invest in rapid innovation to develop new, cleaner fuel sources, new ways to influence Earth's climate, and even new societal arrangements. **BUT** we may not make progress quickly enough to avert the worst climate-change impacts, and some new ventures will fail or cause other environmental problems.

| Examples of What Could Be Done | Some Trade-Offs to Consider |
|--|---|
| Offer companies incentives for developing technologies that help build a low-carbon economy. | The government would be interfering in the private sector. |
| Strengthen development of geoengineering—scientific methods for modifying Earth's climate. | The outcomes and negative consequences of geoengineering are unknown. |
| Ease regulatory processes to bring new "green" technologies to the market more quickly. | Some harmful new technologies may slip through the cracks if we loosen our standards. |
| Give businesses and nongovernmental organizations wider latitude to direct research at American universities. | Businesses and organizations could "buy" research and unduly influence America's academic institutions. |
| Use technologies like "smart" electric meters and GPS devices, combined with peer pressure and social media, to encourage people to reduce energy use. | This raises privacy and security concerns, and could lead to inappropriate public pressure. |

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