NATIONAL AFFAIRS

A Practical Approach to Climate Change

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Climate change resulting from human activity likely poses the biggest environmental risk modern society faces. Its impact could be global, its long-term costs are likely to exceed those of any other environmental challenge, and its effects probably cannot be entirely averted, regardless of the choices we make. To address these potential dangers, the environmental movement and the political left have offered numerous policies and proposals, but nearly all of them have been profoundly flawed.

Those flaws stem not so much from the proposed higher taxes, diminished individual freedom, and expanded government control over the economy—although the left's proposals would make all of those mistakes. They come from an excessive faith placed in mere assumptions about what is an intractably complex problem, and from insufficient flexibility should those assumptions prove mistaken.

Although climate change could be a major challenge, many of the most important and effective means of confronting it are likely to involve relatively modest steps, such as limiting government activity in areas likely to prove maladaptive, increasing government efforts in a few select areas, and unleashing the private market to solve problems. Among the specific steps toward these ends that policymakers should consider are slashing subsidies to activities that either promote climate change or that forestall adaptation; committing to "source agnostic" public investments in a "smart grid" that would move power around the United States, while encouraging distributed generation; enacting a swap of carbon-dioxide taxes for other tax cuts to stimulate the

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economy; and ramping up funding for scientific research in a variety of cutting-edge fields, perhaps most notably geo-engineering.

Above all, preserving a generally prosperous, dynamic economy capable of responding to any future changes in the climate (or anything else) is probably more important than any other public policy. By approaching the problem of climate change with humility, we can remain flexible, ready, and able to respond to whatever challenges the future might hold.

what we know and what we don't

Hardly anyone who has taken a serious look at climate change can dispute two fundamental facts: The earth has warmed, and human activity — particularly the burning of fossil fuels — has had a significant impact on this warming.

First, the earth has grown steadily warmer since the Industrial Revolution, and the pace of warming has increased in the past 40 years. Twenty of the warmest years on record have taken place since 1989. Overall, the United Nations Intergovernmental Panel on Climate Change (IPCC) says that warming has been on the order of 1.3 degrees Fahrenheit since 1800. Early estimates and data sets used to document warming were fraught with errors and ambiguities, but more recent analysis of the data (for instance, by the Berkeley Earth group) leaves no room for ambiguity: Warming is real and has continued.

That said, predicting the future rate of warming on the basis of models has proven difficult. Although the actual levels of greenhouse gases known to cause warming are higher than many scientists once believed they would be at this point, the actual changes in temperature have tended toward the low end of most models. For reasons that scientists still do not fully understand — probably related to oceans retaining heat — the rate of warming has slowed quite a bit in the last 18 years. It is not true, however, that global warming has "paused." The overall temperature trend, by any reasonable evaluation of the data, is still headed upward. Estimates produced by the IPCC in April 2014 indicate that temperatures will rise an additional 5.1 to 7.1 degrees Fahrenheit before the end of the 21st century. Given that past climate estimates have been off in a variety of ways, estimates for future increases may also prove inaccurate. But a warmer earth is a near certainty.

Second, human activity is almost certainly the most important cause of the warming. Naturally occurring climate cycles have clearly played a role, but human activity, particularly emissions of greenhouse gases, have played a significantly larger one. It has been known since the 19th century that carbon dioxide and other greenhouse gases like methane, nitrous oxide, and ozone can trap heat. Emitting more of these gases into the atmosphere increases its heat-carrying capacity. While all land-based animals emit CO_2 with every breath they take, plants are the main repositories of it. Over very long time horizons, plant matter transforms into the fossil fuels oil, gas, and coal. When these fuels are burned, the CO_2 from ancient flora is finally released into the atmosphere; the more fuel we burn, the more CO_2 gets released.

There have always been natural fluctuations in global temperatures, of course, and not all natural cycles warm the earth. Major volcanic eruptions, for example, have a significant cooling effect that, over short periods, can outweigh the general warming trend. But the recent overall trajectory is still unmistakable. While natural factors can have significant short-term impact on climate, they are sufficiently infrequent and scattered that they cannot be considered the "cause" of the observed climate change, nor can they explain the recent warming trend. Neither can solar activity, El Niño, or any other factor independent of humans.

Since the upward trend in temperatures has tracked the concentration of CO_2, evidence for the hypothesis that rising CO_2 concentrations impact temperature is nearly unassailable. While most publications in climate science do not advance any hypothesis on the causes of global warming, of those that do, the vast majority endorse a human cause, as does the IPCC and every major academy of science in the world. This doesn't mean, as some environmentalists claim, that the science is "settled." It is correct to say that we don't know *exactly* what is causing climate change, and expressing uncertainty, as politicians like Mitt Romney have, is not the same thing as denying that climate change is real.

Indeed, almost every scientist and climate-change activist inside or outside of the scientific community—and even most of those labeled "climate deniers" by the environmental movement—agrees with the premise that the earth has warmed and that humans have contributed to that warming through CO_2 emissions. Even the *bête noire* of the environmental movement, philanthropist Charles Koch, said so in an interview with *USA Today* in April 2015.

Interestingly, perhaps the most convincing overall evidence that climate change ought to be considered an important public-policy topic may come from the insurance industry. All large companies writing property insurance, as well as the major modeling firms they rely on, project effects from climate change in the present and the future. All of their models show that, on balance, climate change will have negative consequences for the world, and insurance companies have adjusted their policies to account for those consequences. A company that ignored these effects could make large short-term profits by underpricing its competition. Yet not a single firm has done this. The market certainly seems persuaded.

But in this arena as in others, the facts about climate change do not by themselves provide public-policy guidance. Determining the most reasonable responses requires a look not only at the science of warming but at the likely future consequences of climate change. And unlike the established facts about the reality and basic drivers of climate change, there *is* a significant degree of scientific dispute over many of the future potential risks.

The single most certain consequence of global warming is just that: a continued trend toward warmer average surface temperatures and more atmospheric CO_2 throughout the world. Overwhelming observed evidence and the most basic modeling assumptions reveal that this means there will be less sea ice, less permafrost in the Arctic, and less snow and ice almost everywhere on earth. The number of hot days will increase, and the number of cold ones will diminish. Furthermore, since CO_2 is persistent in the atmosphere — its half-life is about a century — these trends could not be reversed on the scale of any human lifespan.

Hotter temperatures and more CO_2 will have a variety of consequences. Not all of them are bad: Cold tends to kill more people than heat, and deaths from cold will probably decline in much of the world as a result of warming. More CO_2 in the atmosphere may increase agricultural outputs in some parts of the world, since plants "breathe" CO_2. Plausible predictions of future atmospheric concentrations of CO_2 will not, in themselves, harm human health. But more heat could have a number of negative consequences as well. Warming likely will increase the number and severity of droughts, increase deaths due to heat, and make it harder for some plants to grow in their traditional environments.

Contrary to the wild claims of some environmentalists, these shifts aren't by themselves going to cause a collapse of agriculture or result in a world that cannot feed itself. The Green Revolution of the 1960s and

1970s increased crop yields enough that plenty of very good agricultural land is now either fallow or has returned to a more natural state. It is even possible that a warmer earth with more CO_2 in the atmosphere could allow farmers to grow slightly more crops per acre or otherwise increase average productivity. So while most scientists don't believe we're headed for imminent agricultural catastrophe, most level-headed assessments of the consequences of a warmer earth do indicate that the negative effects will outweigh the positive ones — largely because they will disrupt the existing ways of doing things. For instance, if farm productivity were to increase in areas that have not historically been agriculturally productive, it would require building significant additional infrastructure to harvest and transport those crops, which would likely impose more costs than whatever productivity gains might result, at least in the short term.

Other parts of the intricate web that supports plant and other life also could be disrupted. These disruptions would be slow to unfold, which raises the odds that the developed world will find ways to adapt, even though costs could be significant. But for societies that practice subsistence agriculture and for small island nations that have self-contained ecologies, the consequences could be devastating. Indeed, much of the best evidence for climate change's *current* consequences exists on such small islands where coral reefs and other delicate ecosystems are already in peril.

Climate change will also likely affect the oceans. Seas have been rising for at least 10,000 years. Warmer temperatures will cause additional rise simply because water expands at it warms. Sea-level rise caused by climate change has been tiny up to now — about 0.11 inches a year — but many scientists believe it will accelerate somewhat in the near term. Even this, however, has been enough to cause a demonstrable increase in coastal flooding. The ranges for sea-level rise that scientists believe are plausible over the next century are so broad that it's nearly impossible to use them to guide public policy; an increase of as little as two feet (which would largely shrink the size of beaches and have little impact on places where people live) is plausible, but so is six feet or more (which would inundate large parts of the Gulf Coast).

An increase in some kinds of severe weather also seems plausible as a consequence of climate change, although the dimensions of this increase remain very difficult to determine. All weather in the world is connected to all other weather, so any major event is obviously affected by climate change and human CO_2 emissions — just as all the weather in the world is also affected by today's temperature in Boise, Idaho. No matter how often environmental groups may call each major hurricane a "wake-up call" on climate change, so far the frequency of hurricanes has not increased as atmospheric CO_2 levels have increased, and little consensus exists as to whether it will in the future. (Some models used in the insurance industry predict *fewer* land-falling hurricanes in a warmer world.) There is a fair amount of evidence, none of it conclusive, that hurricane intensity has increased coincident with rising CO_2 levels and the warmer ocean waters that result.

Hotter, drier conditions are also likely to result in more wildfires and droughts in the future, but again evidence linking recent events to warming appears limited and sometimes contradictory. Climate change likely has had some impact — although not a major one — on the increased disaster damage we have seen in recent years, but more of the increase has resulted from more people living in harm's way.

Finally, a number of very severe consequences appear *possible* in the longer term, but should not be thought of as likely based on existing evidence. For example, rising temperatures potentially could disrupt and eventually cause entire ecosystems to collapse — increasing an already high level of human-caused species extinction — and leave certain biomes almost entirely sterile. This loss of biodiversity, which should be considered a problem in itself, could also make it harder to develop new commercially viable crops or discover new drugs because of decreasing opportunities to learn from diverse natural ecosystems. Likewise, the melting of Arctic permafrost potentially could release large amounts of methane into the atmosphere. Since methane itself is a greenhouse gas and far more potent than CO_2, this could lead to a "runaway greenhouse effect," which would send temperatures soaring beyond those predicted in most current models.

But people who speak about these kinds of scenarios as being "certain" or even "nearly certain" deserve to be labeled "alarmists." Life on earth has proven remarkably adaptable and human ingenuity makes it even more so. Nonetheless, it is hard to find a climate scientist who has studied these possibilities who believes that they can be ruled out *entirely* as potential risks. Thus, any rational public policy should take these and other extreme potential scenarios into account as risks, even if the preponderance of the evidence shows they are unlikely.

While there can be little certainty about the precise future consequences of climate change, a review of the facts indicates the negative consequences are likely to outweigh the positive ones by a significant margin. This alone suggests that public policy ought to look for ways to mitigate harms and avert risks. But policy responses informed by a balanced view of the risks will not look like the proposals generally championed by liberal politicians and most environmental advocates.

ELIMINATING HARMFUL SUBSIDIES

A rational climate-change policy should begin by shrinking government rather than expanding it. In particular, it might start by ending all policy inducements likely to be maladaptive with regard to the known and knowable consequences of climate change.

Governments collect taxes and spend in order to provide public goods and correct market failures. When government subsidizes environmentally destructive behavior, it damages the stock of public goods and misallocates resources. Although the specific subsidies worth cutting vary from place to place, three categories of subsidies — those for development near water, for obviously "dirty" fuels, and for certain agricultural practices — stand out as key targets for elimination.

Since sea-level rise is one of the easiest-to-predict consequences of higher temperatures — and is inevitable in many areas because of falling coasts, even if temperatures were to stop rising — the federal government should stop encouraging people to live near water. Subsidies for high-risk properties in the National Flood Insurance Program (which Congress voted to cut in 2012 and then partly restored in 2014) should be eliminated. Congress and the insurance industry should look for ways to transition the program over time to the private sector.

Other, related efforts, including federally funded "beach nourishment" — which dumps sand that is sure to be washed away and thereby induces development in the areas most likely to face climate-change effects — deserve similar targeting for speedy elimination.

But a complete land-development agenda shouldn't just withdraw a few selected subsidies. Instead, leaders should look to expand the hugely successful but little known Coastal Barrier Resources Act of 1982. A key environmental initiative of the Reagan Administration, the act barred essentially all federal subsidy programs, except those related to research and some limited recreational uses, from operating in previously undeveloped barrier islands and barrier beaches along the Atlantic Coast and Great Lakes. The 3.1 million acres the CBRA protects comprise an area larger than all but one national park in the lower 48 states. Private individuals can still build in these areas, subject to local zoning codes, but the government will not help them do so. A 2002 Fish and Wildlife Service study concluded that the system would save almost $1.3 billion (in 1996 dollars, or more than $1.9 billion today) in forgone subsidies between 1982 and 2010.

The concept of CBRA should be expanded to additional wetland areas on the Pacific coast, near rivers, and further inland from the actual coast. Members of Congress should also consider creating similar "subsidy-free zones" in box canyons and other areas that appear particularly prone to wildfire. A wide range of agricultural subsidies, many of them labeled "crop insurance," also should be targeted for elimination on similar grounds.

If policymakers hope to reduce CO_2 emissions, they should also stop subsidizing energy production of all kinds. Unlike subsidies provided for such public goods as education and national defense, the benefits of energy are clearly captured by those who pay to consume it, with no positive social externalities. The environmental case (let alone the economic case) for ending subsidies for CO_2-emitting fossil energy is obvious. The case for ending subsidies for cleaner, trendier forms of energy may be less obvious but no less compelling.

Dozens of programs encourage the creation of solar power, wind power, ethanol, and other politically popular renewables. Many alternative-energy subsidies, particularly those for biofuels like ethanol, may not produce net environmental or CO_2-reduction benefits at all. Some hotly debated research, mostly conducted by Cornell University's David Pimentel, indicates the total production process of biofuels (farming, harvesting, processing, and shipping) uses significant amounts of fossil energy, emits lots of CO_2, and may, in the end, be energy-negative. Other reports from the powerful California Air Resources Board show ethanol isn't a net CO_2 benefit, because burning corn to create fuel creates demand for more CO_2-intensive grain production elsewhere in the world.

Other alternative energy sources clearly involve less CO_2 emission, but they are economically irrational in ways that threaten to lead energy producers to make well-intentioned bad investments that ultimately undermine their own goals. Simply put, the technology to deploy these alternatives on a meaningful scale does not exist, and subsidizing their use is therefore likely to be counterproductive.

Wind and solar technology, for now, simply cannot produce energy in enough density at the right times to supply areas with large populations. Battery technology to allow wind and solar energy to be stored, while advancing quickly, remains immature. Efforts to harness the tides and internal heat of the Earth are similarly impractical on a large scale. Because of the amounts of construction and use of fossil fuels needed to transition to these forms of power on a large scale, some green-energy projects may take decades to produce a net reduction in CO_2. In the long term, better transmission, generation, and storage technology could solve these problems. But in the short term, the technology simply does not exist to depend on any of the trendiest power sources for "baseline" power. For quite some time to come, fossil fuels will have to remain part of the mix.

This isn't to say that these alternative sources are bad. In principle, it would be best to switch to wind and solar power: Their generation produces no CO_2 or other pollution, and the supplies are for all intents and purposes inexhaustible. But subsidizing their *deployment* before the necessary technology or infrastructure is ready will harm the development of precisely the technological advances required to make them viable.

This problem is not just theoretical; it is exactly what happened to nuclear power. Between the mid-1950s and early 1980s, nearly all scientifically advanced countries embarked on programs to build nuclear reactors. Although some countries did develop their own technologies — the Soviet Union built dangerous, graphite-moderated reactors, and Canada used domestically developed heavy-water technology — the overwhelming majority of reactors and nearly all of those in the United States were light-water moderated thermal reactors based on uranium and its product plutonium. As a 2011 report from the Union of Concerned Scientists outlines, nearly all of these reactors required massive subsidies. They were technologically feasible largely because the scientific developments necessary to build them were logical and easy extrapolations of nuclear-weapons production. The first nuclear reactor connected to the power grid went online in England only 11 years after atomic bombs ended World War II. While these reactors do generate clean, reliable power and, in the United States and Western Europe, have an exemplary safety record, they also produce lots of nuclear waste and use outdated technologies.

Since the 1960s, scientists and engineers have found that another fuel, Thorium, is in some respects superior to uranium. Laboratory advances have been made that produce far less waste (fast neutron reactors); that produce their own fuel while, theoretically, leaving no waste behind (fast breeder reactors); and that contain elaborate passive safety features that could make serious accidents essentially impossible (very high-temperature reactors). But few of these ideas have advanced far beyond a small number of experimental units, because so much research, capital, and smarts have gone into the subsidized older technologies that stemmed from the weapons industry. Furthermore, because industrial economies of scale exist only for the older technologies, the newer, potentially superior technologies are likely to remain difficult to implement on a large scale without further subsidies.

Nuclear power, if allowed to develop on its own, would have grown more slowly. While this would have had some serious disadvantages such as more air pollution, it might also have put the nuclear industry on a firmer footing today. Instead, much of the current nuclear industry is locked into technology that clearly remains behind the times. Similar deployment subsidies for other technologies might lock them into the same types of blind alleys.

BRIDGING THE GAP

If nuclear, wind, and solar power all lack for commercial viability in the short term, then many of the proposed "solutions" to climate change most favored by the environmental movement and politicians remain out of reach. But one fuel, natural gas, which is widely demonized in certain segments of the environmental movement, does provide a path to significantly lower carbon emissions now.

Thanks to new hydraulic fracturing techniques (which break apart rock deep inside the earth to release gas) and massive amounts of newly discovered gas, natural-gas prices have fallen drastically and known reserves have increased dramatically. Because gas burns far cleaner than coal and is now cheaper in most cases, it has been widely substituted for coal. The growth of natural gas has had an enormous impact on national CO_2 emissions. Thanks in large part to increased natural-gas use, the United States produces fewer greenhouse gases than it did in 1996 and may well reach 1990 levels soon.

While the fracking that provides access to much of this gas isn't environmentally benign, there's little solid evidence of any major harms. Extensive tests show little to no significant water pollution in most places (something that's worth monitoring since fracking does involve injecting chemicals into ground water). Leaks of methane, a potent greenhouse gas, have actually declined around natural-gas production sites as fracking has grown.

While gas does release some CO_2 when it burns, the IPCC estimates that its lifecycle CO_2 production is less than half that of coal. Replacing coal-fired plants with natural-gas plants can provide huge reductions in emissions, while actually making electrical power *cheaper* on balance in the United States, all without a penny in subsides. Since gas produces almost none of the pollutants that are dangerous to humans at atmospheric concentrations, the environmental benefits of a switch to gas will accrue far beyond simply reduced CO_2 emissions. Even better, natural-gas production does not destroy mountains or disturb the landscape the way coal mining can. It produces no nuclear waste, requires less physical infrastructure than some forms of oil drilling, and does not have the massive land-use requirements of utility-scale solar and wind technologies. In fact, there's a strong possibility that it would be possible to use sequestered CO_2 to aid in more fracking.

In short, natural gas is probably the least environmentally harmful way to get significant amounts of cleaner energy immediately. Efforts to increase U.S. gas production, reduce prices worldwide (including by allowing exports of U.S. production), and otherwise encourage the use of gas offer the surest, swiftest, and most economically efficient road to reduced CO_2 emissions and less pollution overall. Figuring out ways to reduce CO_2 emissions from gas facilities deserves further research and experimentation, too.

Other proposed new energy production in the industrialized world will also have beneficial effects. Take, for example, the Keystone XL Pipeline, the white whale of the environmental movement. The pipeline would increase the efficiency of oil transportation from Canadian tar sands, which is more CO_2-intensive than oil extracted by some other means. Further, by unlocking more oil, the project presumably would encourage more use through lower prices. But in fact, as studies by MIT energy economist Chris Knittel have shown, the pipeline is actually likely to *reduce* total CO_2 emissions by displacing more CO_2-intensive ways of shipping oil and by replacing oil sources that pollute more than tar-sands oil.

Some other U.S.-based projects that arouse controversy likely promise similar net benefits for the environment. Since total energy demands have shrunk modestly in the United States over the last decade, new American production has simply displaced older or less-clean production elsewhere in the world and will continue to do so, especially as the U.S. becomes a net exporter of energy. (It probably could be already if natural-gas export bans were lifted.) Of course, some new energy-related projects in some places may have negative overall environmental consequences, and almost all will in the immediate area where they take place. But almost any new energy production proposed in the United States and other developed countries is likely to improve the environment overall and help deal with climate change, as their updated technologies will almost certainly be cleaner than the older technologies used elsewhere.

The goal shouldn't be "energy independence." No modern country is fully independent for any key resource, and various unsavory regimes will always be able to profit off the sale of resources no matter who buys them. Rather, our goal should be to shape the best and most efficient energy industry the United States can have. In the medium term, using newer technology to produce more natural gas and other forms of energy offers a good way to help the environment and reduce emissions.

BETTER ELECTRICITY

Given the uncertainty about which energy sources in which combination will work best to meet future needs, public policy will do the least harm and most good if it focuses on those things that government is uniquely capable of: building good "network infrastructure" like better power and gas distribution grids while simultaneously making sure that incumbent players don't try to destroy new technologies.

Building bigger, more robust systems for distributing energy of all kinds represents a key responsibility and duty of the government. Like paving roads, building large-scale power lines and pipelines requires eminent-domain powers that belong uniquely to the state. While forcing property owners to grant easements should not be done willy-nilly, it is sometimes necessary to make room for a public good, and a stronger and more robust electric grid would benefit the entire country.

At this point, four major new policies are needed in order to improve the efficiency of the power grid. First, there should be a strong presumption in favor of allowing and facilitating the construction of any high-capacity power line or pipeline the private sector wishes to build. Nearly all proposed renewable-energy technologies are likely to be intermittent (wind power only works when the wind blows, solar only when the sun is shining), and using them on a large scale will require much better infrastructure to move power from one place to another, as well as improvements in battery storage. Even if these trendy forms of power never work on a massive scale, having infrastructure that could support them would benefit the economy anyway.

For a wide variety of historical and economic reasons, it remains hard — sometimes impossible — to move power all the way across the country. Right now, no high-capacity power lines run in straight lines from the major centers of the east to those of the west. In fact, more high-capacity power lines connect Canada and the United States than the east and west coasts. Getting alternative energy to work will require more of this infrastructure to be built.

Second, ongoing efforts to deploy a "smart grid" that uses internet-related technologies to monitor and distribute energy deserve support. Little if any of this technology requires overt government subsidies for deployment in most areas, but in many cases regulations and policies can still play a role in standardizing it and moving it forward. Government certainly has a more assertive role to play in security, to protect the stability of the grid from attacks by terrorists or enemy nations. Many smart-grid technologies would help to do this, and a few related to monitoring might even be worth implementing on national-security grounds alone.

Third, distributed generation — the ability of individuals to produce their own power and sell it back to power companies — deserves expansion. In the short term, this consists largely of two related technologies that are already in reasonably wide use: waste-heat cogeneration systems in businesses and solar panels on home rooftops.

Cogeneration systems (which also exist in utility-scale power plants) use the heat generated from boilers, air-conditioning systems, and industrial processes to generate electricity or heat water. This process is financially viable without subsidies today, and allowing businesses and factories to sell otherwise unused power back to utilities could encourage even larger applications while reducing pollution and climate change. Rooftop solar cells, which can be installed at little to no cost to homeowners thanks to leasing arrangements, also have enormous promise. Policymakers should support changes that would allow such homemade solar power to be sold back to power companies at mutually fair prices; they should also work to cut the red tape that impedes solar-cell installation in some neighborhoods.

Other forms of distributed generation — home wind generators, small-scale fuel cells that could power neighborhoods — remain less mature but may become more practical in the future. But however promising these technologies may be for environmental reasons, they all have the potential to disrupt the business model that utilities and power generators rely on. There may be tradeoffs in access to utility-generated power in more remote areas and reliability problems (at least for those who don't have their own systems) that policymakers will have to deal with or at least acknowledge.

Fourth and finally, in part to pay for distributed generation, regulators should look for innovative ways to bring private capital into the market. While a variety of mechanisms, including special-purpose bonds and taxpayer-supported authorities intended to make energy upgrades, may be attractive in some areas, there are a few ideas ready for widespread adaptation. Property Assessed Clean Energy (PACE) programs — which add special voluntary assessments to property-tax bills to pay for clean-energy upgrades to properties — provide a way to upgrade energy infrastructure in commercial properties in a way that seems essentially "free" to their owners. PACE programs already exist in many places, and several other programs with similar potential should get wider use.

One idea developed by the Environmental Defense Fund that deserves particular attention is on-bill repayment (OBR) for energy improvements. Under an OBR regime, homeowners and businesses can finance energy-efficient improvements and then pay them back via a surcharge on their power bills. Since electric bills almost always get paid, even in homes that are facing foreclosure, lenders can make loans at very favorable interest rates. Because OBR payments are the responsibility of whoever pays the electrical bill, rather than the person who makes the improvements, the system also removes disincentives for renters to make energy improvements with payback times that are longer than their leases.

These kinds of steps are important because they are "source agnostic." A better grid would save energy, boost economic productivity, and reduce emissions, whether the power comes from wind and sun or continues to come from a broad mix of sources. No investment in the grid itself or the ability to generate power in a distributed fashion would rule out any new energy technology, and having a better grid in place will make many new technologies, including some that may exist only in lab notebooks today, far more viable.

A TAX SWAP

Ever since climate change became a major public-policy issue, various schemes to tax emissions, either under "cap-and-trade" or a straight carbon-tax regime, have received significant attention from the political class. Imposing a price on CO_2 emissions would allow society to recover the costs of the externalities produced by energy production and use, and would encourage a reduction in those emissions.

Although many cap-and-trade schemes exist, only a handful of jurisdictions—British Columbia, Ireland, and Sweden most prominently—have implemented true carbon taxes. Creating one in the United States—nationally and on a revenue-neutral basis—would be a good idea, although not for the reasons many environmentalists believe. Quite simply, a carbon tax would be a good way to cut taxes on productive activity and free the economy to become more prosperous.

The environmental effects of a carbon tax would probably disappoint the policy's most ardent proponents and underwhelm its most vocal opponents. First, a U.S.-only carbon tax could have only quite limited environmental effects. The Department of Energy's Carbon Dioxide Information Analysis Center finds that the United States emits only about 17% of the world's CO_2, while China emits more than a quarter and the EU as a whole about 13%. The United States has already made progress; American CO_2 emissions have fallen faster than those in Europe over the past decade. This doesn't mean that a carbon tax wouldn't help further reduce emissions, but its global effect would be limited.

Second, claims that a carbon tax would somehow, by itself, create a "green economy" are unsupported. Europeans and the Japanese already pay total gas and fuel taxes that raise energy costs far higher than those in the United States, and they have actually seen their CO_2 emissions increase (albeit from a much lower level), even as those in the United

States have fallen. While America's size and unique capacity for innovation might inspire the faster development of new technologies, simply imposing a price at any politically plausible level is probably not going to create a technology revolution immediately.

Yet if the potential environmental benefits of a carbon tax have been oversold, its costs have been overstated too. The highly respected environmental research organization Resources for the Future estimates that a $25-per-ton carbon tax — roughly a middle ground in economic calculations for the "social cost" of emissions — would raise gas prices 21 cents per gallon and diesel fuel about 25 cents, while electricity would go up 1.2 cents per kilowatt hour. A politically viable carbon tax would therefore almost certainly have to start at a level lower than that. Although a tax at this lower level would still influence behavior, it probably would not be as visible at the gas pump or in electrical bills. Furthermore, the estimated costs associated with potential carbon taxes are all well within the normal range of price variability that naturally occurs due to new fossil-fuel discoveries, weather, and fluctuations in overall demand. Since the economy handles changes like this all the time and energy represents only 6% of the overall economy, this is unlikely to have huge economic consequences for the worse.

Recognizing that a carbon tax won't do net economic harm, however, is far different from saying that it's a good idea. In fact, a carbon tax in isolation is probably *not* a good thing for the economy any more than any other tax is. But no tax can be fairly considered in isolation.

The real promise of a carbon tax is the potential boon that could be realized from a tax *swap*. Right now, the United States funds its federal government largely by taxes on personal income, corporate profits, investments (capital gains and dividends), and labor (payroll taxes). Most everyone would agree that it's better to have more of all of these things than less. While a 20% increase in tax rates will not always result in a 20% decline in work effort, it's quite clear that lower taxes on these activities produce more of them than higher taxes do. Cuts to personal income-tax rates championed by Presidents Kennedy, Reagan, and George W. Bush helped spur long economic expansions.

Unfortunately, today's large budget deficits and long-term shortfalls to pay for entitlement programs make significant future tax cuts very difficult. Cutting taxes in the future, therefore, will require shifting the tax burden to something else. A tax on something the nation clearly should want less of but will produce plenty of anyway — carbon emissions — is a perfect target.

That's why conservative economists like Kevin Hassett and Arthur Laffer are carbon-tax proponents. For example, at $20 to $25 per ton, a carbon tax could raise enough money to eliminate the entire employee portion of the Medicare payroll tax or to reduce statutory corporate income-tax rates to around the OECD average (America's statutory corporate tax rates are currently the highest among wealthy OECD nations). This swap would work even while preserving most existing tax credits. As a political strategy, it is crucial that carbon-tax proponents on the right insist on pure revenue neutrality. Even agreeing to spend a few dollars on some genuinely worthy purpose like deficit reduction or a smart grid would open the floodgates to turning the carbon tax into a pork-filled mess similar to the unsuccessful Waxman-Markey bill pushed by the Obama administration.

A carbon tax isn't perfect tax policy, and policymakers will have to pay careful attention to the specifics of its design. Most important, an effective carbon tax would have to replace almost all other mechanisms used to control CO_2. Policymakers should start by revoking the Environmental Protection Agency's authority to regulate CO_2 emissions. The Supreme Court may have ruled that the Clean Air Act essentially requires the EPA to regulate CO_2, but that doesn't mean this regulation is a good idea. The pollutants that the authors of the Clean Air Act had in mind — things like sulfur dioxide and nitrogen dioxide — are intrinsically harmful to human health in a way that CO_2 is not. What's more, those pollutants are emitted by a reasonably small number of facilities, have almost all of their effects in the local area where they are emitted, and tend not to stay in the atmosphere for long periods of time. The strategies needed to control them are thus quite different from those appropriate for controlling CO_2. Even Waxman-Markey recognized this and suspended the EPA's authority temporarily. A carbon-tax swap should do so permanently.

A number of other regulations around energy efficiency, such as Corporate Average Fuel Economy (CAFE) standards for automobiles, might also be done away with as part of carbon-tax implementation. Many restrictions on extracting resources, likewise, could largely be done away with since the carbon price would also factor in many of their costs.

The best argument for a carbon tax is simply that it's a good way to cut taxes on productive activity that society wants more of, while discouraging something that everyone ought to want less of. Given the uncertainties implicit in climate change, an economy with low taxes on productive activity and therefore higher growth will be more able to cope with the effects of a warming climate, even if the tax itself does little about it.

GEO-ENGINEERING

A modest strategy that emphasizes such small steps should offer the best solution to the most likely "goldilocks" climate-change scenarios: those that involve significant challenges but do not threaten human civilization. Such a humble agenda, however, could not cope with the worst plausible scenarios of climate change. And almost no climate scientists are willing to rule those out absolutely. Indeed, if these disasters are on the way, then there's already little we can do to stop them. Even under the lowest-carbon scenarios and barring any unforeseen and unprecedented technological breakthrough, CO_2 levels in the atmosphere are likely to continue rising globally for several decades at least. If there are "points of no return" that are close to current CO_2 levels, humanity will likely breach them regardless of any public policy.

This possibility, along with the fact that its probability is low, suggests that the public would be well served by some modest but meaningful investments in "geo-engineering"—the science of intentionally modifying the planet's atmosphere. If burning fossil fuels has inadvertently modified the climate, it's highly likely that deliberate action can do so too. Indeed, a combination of uncontroversial, no-regrets activities and cutting-edge science worthy of pulp magazines can do a lot to prepare humanity for the worst possible scenarios.

The most obvious and clearly efficacious act of geo-engineering is also the least controversial: growing more plants around the world. Since plants all sequester carbon, preserving existing forests, replanting wherever logging takes place, and restoring peat bogs (particularly potent carbon sinks) is an excellent policy. No organized group actively opposes these things and, since a more CO_2-rich atmosphere is likely to result in more plant growth, these plans are likely to become marginally easier anyway as CO_2 levels rise.

Efforts to reduce deforestation in the less developed world—which can be done through electrification, freer trade, and improved farming practices — also deserve strong support from major international aid donor nations like the United States and Japan. A targeted, high-profile effort to discourage deforestation around the world, modeled on the Bush administration's President's Emergency Plan for AIDS Relief, seems in order. Unfortunately, simply having more trees appears very unlikely to absorb enough CO_2 to deal with the worst possible scenarios. This will require more drastic action.

Such action can cover a wide spectrum. Some proposed models suggest that reasonably simple and cheap actions could have a major impact. Observed evidence from major volcanic eruptions shows that putting even a relatively small amount of sulfur dioxide into the high stratosphere will cool the earth. So could using "cloud ships" at sea to spray fine mist into clouds and reflect more solar radiation back into space. Scientists already have shown ways that fine aerosol particles from land could do the same. Painting building roofs white throughout the world would reflect more sunlight into space and potentially reduce temperatures.

Some other proposals seem to involve a lot more risk: Dumping lots of iron into the ocean, for example, could stimulate plankton growth and sequester huge amounts of carbon, and dumping lime could help reduce acidification, but either could also do massive damage to ocean ecosystems. More far-fetched schemes have also been proposed, though it is hard to see how their risks could be well predicted and managed. Capturing and pulverizing a near-earth asteroid or detonating a nuclear bomb on the lunar surface, for example, could create a dust cloud around the earth that would reflect solar radiation. These are not plausible ideas as they stand. But research into aggressive geo-engineering techniques to be called upon in case serious problems arise would be a prudent insurance policy against the worst possible climate-change scenarios.

WIN-WIN STRATEGIES

Climate change is real, human caused to a significant extent, and likely to pose some real problems. While near-apocalyptic nightmare scenarios do not seem likely, even they should not be completely ignored. Yet taking climate change seriously must not mean undermining our economic potential. On the contrary, the best way to deal with such a complex tangle of risks and uncertainties is to have the most resources possible to confront it. A wealthy future society will be able to pay the costs of climate change even in reasonably serious scenarios, while a poorer one will not.

Developing those resources for the future is largely the job of the private sector and the market economy. In many cases, policymakers can do the most good by getting out of the way, reducing maladaptive subsidies, cutting taxes on productive activity, reducing regulation, and increasing overall energy production. Beyond that, an agenda of energy and climate research (broadly understood), along with smart-grid development will help America be maximally prepared and capable.

To deal with climate change seriously and prudently, political leaders should pursue humble policies that render the country and the planet more free, more prosperous, and more innovative.