

## The Hidden Risks of Energy Innovation

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[This is a pre-publication version of an article that was published in the Winter 2013 issue of *Issues in Science & Technology*, published by the National Academy of Sciences.]

Recent years have been disappointing for U.S. advocates of aggressive action on climate change. Efforts to pass comprehensive cap-and-trade legislation, which would have promoted the deployment of clean energy by making dirty energy more expensive and thus cut U.S. emissions, failed spectacularly. Global climate change negotiations, expected by many to deliver a legally binding deal that would sharply constrain global greenhouse gas emissions, have done nothing of the sort. Meanwhile, warnings of dangerous risks in the climate system have mounted.

People who understand that the climate problem is serious have reacted by grasping for new ways that government can lead on this front. Out of this searching, a big new idea has emerged: The world can cut through the dead-end politics of climate policy by focusing on clean technology. At home, rather than penalizing dirty energy, government would step in to help make clean energy cheap, a much more positive agenda that its proponents argue would eventually encourage mass adoption of low-carbon energy sources. Internationally, virtuous competition to win a clean energy race would replace the tired and unproductive squabbling that has marked efforts to agree on emissions constraints. Cheaper clean technologies would also mean that developing countries, where most future energy demand will come from, will fuel their economies cleanly, since cheap low-carbon options will become the ones that also enhance economic growth.

Alas, the turn from regulation to innovation is not a magic recipe for eliminating conflict over domestic or international policy, or even for significantly reducing it. Instead, it will create new fights in new spheres. This is not a reason to reject a big technology push as part of a serious climate strategy; climate change needs to be confronted, and conflict is almost certainly endemic to serious climate policy. Nonetheless, before policymakers place their bets on technology policy, they would do well to better understand the opportunities for conflict that lurk there. If they do, they will realize the limits of technology policy and will more likely pursue a modest but constructive approach. If they do not, the more likely outcome is a drive that tries to do too much with technology policy. But just like the maximalist efforts to solve every climate problem with cap-and-trade and an international treaty, that overstretch is likely to beget failure.

### **Promise and problems**

The political logic motivating calls for a new focus on technology in U.S. domestic policy is straightforward. Americans do not like regulation, as is evident in their reactions to cap-and-trade, but they are enthusiastic about innovation and technology. They are averse to constraints, and whereas cap-and-trade was squarely about limits, technology promotion is about expanding options and possibly stimulating economic growth. Moreover, many see greenhouse gas regulation as being about creating losers, most notably in fossil fuel industries and those who depend on those industries for energy; technology promotion, in the new narrative, is about creating new winning industries and large constituencies who can gain from the options they provide.

The international case for a focus on technology is similarly straightforward. Traditional climate negotiations are about spreading the pain of emissions reductions. Each country fights to ensure that it is spared onerous obligations and that others bear as much burden as possible. Focusing on technology would sidestep that fight. If clean technology becomes cheaper than dirty fuel, then all countries will want to adopt it, and there will be no burden to be shared. Climate diplomacy is also immensely complicated. Negotiations over rules for measuring emissions and schemes for trading greenhouse gas credits take diplomats deep into difficult details. Technology, by contrast, appears to harness markets straightforwardly to help spread low-emissions behavior without the need for major international coordination or technical negotiation.

Much of this appears persuasive, yet there is good reason to believe that it is wrong. Americans may not like regulation, but they do not appear to like government spending or taxes either. Yet without new taxes, spending, or regulation, government has no significant tools with which to promote clean energy innovation. Technology promotion can superficially appear to be purely about encouraging growth—cheaper energy should mean more economic activity—but that ignores the cost of promoting clean technology in the first place. Indeed, ill-conceived government efforts to cut the cost of clean energy would simply spend taxpayer funds without producing any real world payoff. In addition, technology policy, if it is to succeed in dealing with climate change, will inevitably create losers alongside its winners. Cutting emissions requires not only using more wind, solar, and nuclear power, it also requires using less coal and oil.

Further problems loom on the international front. Technology promotion, just like emissions cuts, requires dividing a pie. The only difference is that the pie is a new one. Only so many wind turbines, solar panels, and nuclear reactors can be sold into the international market, and countries (and their firms and workers) will fight to maximize the fraction that are theirs. Moreover, a race to develop clean energy will not necessarily spawn a race to deploy it. Technology policy can make clean energy cheaper, but not necessarily cheaper than fossil fuel alternatives, particularly existing coal power plants whose capital costs are already sunk. Policy interventions such as cap-and-trade or regulatory mandates, with all the political challenges they entail, will still be required to tip the scales.

None of this means that clean technology policy should be neglected. After all, it is not as if other dimensions of climate policy are problem free. Policymakers will need, however, to confront the challenges of crafting effective technology policy head on. They will also need to take special care to maximize the odds that their policies are well designed. The fact that people are skeptical of government efforts to promote economic and technological change increases the importance of ensuring that technology promotion efforts are seen to succeed.

## **Navigating the home front**

Domestic policy design faces one central question: Where should government intervene? This question is easiest to settle at two extremes. Technology in the earliest stages of research will be hard pressed to find significant commercial support. Ideas are leaky even with robust protection of intellectual property; investments by one firm in creating knowledge will often redound to the benefit of others instead. Economists have thus long identified spending on research as a place where governments can and should intervene constructively in markets. Those making U.S. energy policy should take that advice.

At the other extreme is mature and commercially established technology. Here, government should largely avoid subsidizing deployment. Some will argue that intervention is justifiable on environmental grounds. Subsidies to deploy wind turbines, for example, may make sense because of the value of wind energy in reducing emissions. But this is not a fiscally feasible path in the long run. Subsidizing the deployment of clean technology at a scale that would actually create deep cuts in U.S. greenhouse gas emissions would eventually cost hundreds of billions of dollars each year.

It is much more difficult to determine what makes policy sense in between. That territory, where developers build full-scale first-of-a-kind projects to demonstrate the feasibility of new technologies, scale up their businesses, and learn how to reduce costs through early stage commercial deployment, is known as the "valley of death" for good reason. There are only so many investors willing to risk significant amounts of money on unproven technologies that might take many years to turn a profit, particularly when the long-term policy picture is so unsettled and the ultimate market is unknown. Without government intervention, many promising inventions inevitably wither here on the vine.

This problem has been recognized in many areas of technology, but it is particularly acute when it comes to energy. During the past 60 years, and particularly over the last 30, the venture capital industry has become critical to shepherding technologies through the valley of death, removing much of the need for government intervention. It has been particularly successful in areas such as information technology and biotechnology. Encouraged by the recent explosion of Silicon Valley interest in clean technology, many people who think about energy assume that venture capitalists will play the same role in clean energy as they have in other fields. But most areas of energy are a poor fit for the venture capital model. Venture capitalists deploy small to moderate amounts of capital over periods of about three to five years on technologies whose intellectual property can be protected through legal means such as patents and copyrights. This business model is a perfect fit for things like software development, which does not require extraordinary amounts of money, where product lifetimes are short and thus new products can penetrate markets quickly, and where intellectual property is relatively straightforward to protect.

Most types of energy technology, though, do not fit this bill. First-of-a-kind biofuels cost hundreds of millions of dollars, and new-design nuclear reactors or coal-fired power plants that incorporate carbon capture and sequestration cost billions. Capital stock turnover is slow, with vehicles lasting a decade or more and power plants lasting on the order of half a century, which makes rapid market penetration impossible. And intellectual property law is often poorly suited to protecting important advances, including demonstration of the commercial viability of well understood but heretofore undeployed technologies, or innovative business models that bring down the cost of deploying fuel and energy-saving technologies. All of this means that venture capital cannot be counted on to take energy technologies through the valley of death, and that government will need to consider intervening much more seriously.

Yet the prospect of substantial market intervention immediately sends the climate problem back whence technology was supposed to liberate it: the realm of grubby politics and ideology. Just as there are fundamental philosophical divides over the role of regulation in the U.S. economy, which shaped the cap-and-trade

debate, there are big ideological differences over the legitimate role of the U.S. government in intervening deeply in markets for new technology. Indeed, the turn to technology may make ideological fights worse. One can plausibly argue that cap-and-trade does not pick winners and losers in the economy; it simply (and subtly) shifts the playing field. In contrast, an active effort to help technologies bridge the valley of death will inevitably require supporting individual firms and technologies, precisely the sort of behavior that opponents of government intervention often find most troubling. Remember the uproar when the Solyndra solar energy company defaulted on its \$535-million federal loan. Moreover, just as the cap-and-trade debate set off a flurry of industry efforts to shape the system to their interests, so too will a big technology push; the only change will be in the set of supplicants. Indeed, the problem may be worse. With cap-and-trade, fights over the distribution of the spoils were largely inconsequential to the policy's environmental effectiveness. In contrast, successful rent seeking from technology companies may mean that large amounts of capital are steered to dead end firms and ideas, leaving less for real prospects. That would hurt the policy's performance.

### **New sources of international conflict**

The challenges entailed in crafting effective technology policy do not end at the water's edge. Any U.S. technology policy will inevitably need to have two international goals: blunting climate change by maximizing the global deployment of clean technology and strengthening U.S. competitiveness by maximizing the global deployment of U.S. clean technology. Anyone who believes that the second goal can be discarded is not taking domestic politics seriously; anyone who would neglect the first is not talking about climate policy. Yet the two directions will often conflict. Moreover, even when they don't, fights over which country will get a bigger piece of the clean energy market will be inevitable, particularly if countries succeed in making that market grow.

Economists have a straightforward response to these dilemmas. Technology spreads through international trade and investment and by the free and secure flow of ideas. Consumers in one country buy new products made in another; firms set up factories overseas that use their new technology; companies license innovations developed elsewhere. Economists argue that if this international market for technology is allowed to work freely, the United States will maximize its economic gains while also protecting the climate. If that means that wind turbines are made in India, or solar panels are made in China, rather than both being made in the United States, that is simply the market telling the United States that it can make more productive use of its talent and resources. At the same time, the United States can benefit from cheaper clean technology made overseas.

There is much to this argument, but it has important limits. For starters, the decision to trade freely isn't a unilateral one. U.S. policymakers may decide that a liberal system of trade and investment will help square their climate and economic objectives, but China may choose not to play along. U.S. policymakers will then be forced to select among unattractive alternatives, whether acceding to large market distortions or choosing to launch a trade war. Either way, free market dogma will not tell them what to do.

Moreover, the same market failures that exist domestically—underinvestment in

R&D, a lack of capital and patience in the valley of death—also exist internationally, suggesting that optimal economic outcomes will require governments to correct those flaws. Yet there is no reason to assume that such interventions will make the United States better off. Just as policies that improve domestic economic efficiency need not benefit all firms, it is perfectly plausible that international policies that look sensible from a global economic standpoint will not be beneficial to all countries. For example, the most efficient policy for moving new energy technology through the valley of death may encourage U.S. inventions to be manufactured in China, which may not ultimately benefit the U.S. economy. Moreover, even if a given policy will ultimately benefit Americans, voters may distrust it and demand measures that more explicitly assure them a big slice of the pie. Alas, the results are unlikely to be ideal.

There is also a deeper problem that is peculiar to clean energy. Efforts that succeed in reducing barriers to international trade and investment, and hence greasing the wheels of technology diffusion, may end up gutting markets for clean energy. Why? As long as clean energy is more expensive than dirtier alternatives, other domestic policies will still need to tip the balance toward investments in clean options. Such policies, though, are often advocated on the grounds that they are good for national competitiveness. U.S. policymakers, for example, have often made the case for climate policy by arguing that it will strengthen U.S. industry. In India, the government has advocated efforts to massively increase the use of solar energy as a way to boost domestic solar firms and has set aside a large chunk of the solar market for them in order to make that point. In China, efforts to deploy large numbers of wind turbines are justified not only as helping with energy security, but also as providing a foundation for a strategic export industry.

Yet a successful effort to knock down trade and investment barriers may mean that domestic firms that would have benefited from policies that encourage clean energy deployment lose out. With those firms no longer poised to gain from domestic policy that promotes clean energy, the political forces advocating low-carbon policies would suffer. Ultimately, demand may be gutted. That would be a loss both for U.S. exporters—a big slice of a nonexistent market is not worth much—and for efforts to combat climate change.

## **A modest way forward**

A shift from cap-and-trade and regulation to technology and innovation will not banish politics or diplomacy from the climate scene, either at home or abroad. But there are steps that prudent policymakers can take to insulate a technology strategy from the greatest risks and to maximize the odds that it will deliver significant payoffs. The key to a successful technology strategy is modesty. A maximalist strategy will run into far more roadblocks and conflicts—and is more likely to fail—than one that seeks to make serious contributions without attempting or claiming to solve the entire problem by itself.

There is no better place to learn this lesson than from the ill-fated climate strategies of the past few years that proponents of a new technology push want to replace. At home, cap-and-trade morphed from a modest attempt to control greenhouse gases into a core fix for a moribund U.S. economy and its dependence on foreign oil. This made for an implausible case. At a very basic level, Americans found it difficult to believe that charging them more for electricity could revive the U.S. economy. It also

required advocates to make sweeping claims that turned off many voters. Many Americans instinctively recoil from claims that regulatory policy is the route to economic growth; they are far more conditioned to the more modest claim that regulation is necessary for the environment. To be certain, the death of cap and-trade was overdetermined. Economic uncertainty and poisonous partisanship were leading factors in its demise. But overwrought claims that it could solve the entire U.S. emissions problem alone, all while delivering a critical blow to economic stagnation, did not help its fate.

The international drive for an all-encompassing treaty suffered from similar problems. A global treaty with commitments to big emissions cuts and significant penalties for noncompliance should have been recognized early on as a nonstarter. States have little certainty as to whether they will be able to deeply reduce their emissions over the coming decades, and since they do not know whether they can actually make deep emissions cuts, they have always been unlikely to make costly promises to that end. Moreover, by choosing the maximalist goal of negotiating a global agreement, states added additional and unnecessary complication. Twenty countries are responsible for about 80% of global emissions, but strategists sought a deal among 192, leaving themselves vulnerable to the machinations of states from Venezuela to Sudan.

A wise technology strategy should be robust yet restrained in its ambitions. At home, it should start with a push on research, while avoiding massive subsidies to the widespread deployment of mature or nearly-mature technologies, which would stretch the government's mission and open it up to reasonable accusations of fiscal irresponsibility. The recently created Advanced Research Projects Agency-Energy (ARPA-E) is the sort of effort that makes sense in this vein; large economy wide subsidies to the deployment of mature renewable energy or nuclear plants are the kind that do not.

Government funds should be used to help move technologies through the valley of death, since without them, the technologies needed to cost-effectively deal with the climate problem are unlikely to materialize. This argues in favor of some direct support for early deployment of technologies such as advanced biofuels and carbon capture and sequestration. But strategists should stop short of advocating federal government spending later in the technology development process, where government is more likely to merely be subsidizing private firms rather than constructively shifting the course of markets. As part of the economic stimulus, some of this was done in areas such as battery manufacturing, but this was done primarily in the context of economic policy, not energy policy. As policy turns to long-term transformation of the energy system rather than efforts to jumpstart a depressed economy, such interventions are harder to justify. Moreover, they have been tainted by public skepticism of the 2009 stimulus; anything that connects a new push on energy technology to that now unpopular policy will make a new energy strategy much harder to sell.

Many will ask how such a limited strategy can solve the U.S. emissions problem. That misses the point. It cannot and should not try to. Regulation and other incentives, including cap-and-trade, carbon taxes, or a clean energy standard, that do not cost the government massive sums of money will still need to play a critical role in promoting fundamental transformation in the energy system. These tools, particularly cap-and-trade, are politically toxic right now, but the climate problem is a multidecade challenge, and there is no reason to assume that the old toolkit is permanently useless.

Indeed, a core goal of domestic technology policy should be to make regulation and other incentives easier. Anything that helps cut the cost of technology will reduce the economic burden of other policies when they are eventually pursued, making them more politically palatable. Seeing technology policy as part of a broader strategy, rather than something that must solve the entire climate problem alone, will allow policymakers to focus it on those areas where it can make the biggest contribution and avoid others that are most likely to get it into trouble.

A similar philosophy should shape U.S. technology strategy abroad. The United States is pursuing international cooperation on research with countries such as China and India, and should continue. In particular, its recent efforts to create joint clean energy research centers with both countries are laudable. It should complement that with a push for liberal markets for international trade and development in clean technologies (something that has been part of the Doha round and has been pursued through Asia-Pacific Economic Cooperation) and for more effective intellectual property protection. That task will be most difficult with China. The United States has already been forced to launch a controversial World Trade Organization suit against Chinese solar panel subsidies, but it should be attempted nonetheless. To maximize its odds of success, the United States will need to work with others since it is not the only country hurt by protectionist policies.

That said, as with the domestic front, the United States should draw limits. U.S. spending on big, near-commercial technology projects in other countries, such as full-scale clean coal plants in China, should be approached cautiously, as it is likely to raise political ire. It is also more likely to be a substantive bust, if only because the big price tags involved in individual projects will make it much tougher for the United States to spread its bets across multiple initiatives.

U.S. diplomats should also stop short of opposing every barrier to trade and investment in clean energy that other countries throw up. Some of those barriers will be necessary to maintain demand for low-carbon technologies. For example, the United States can tolerate some local-content requirements in India's solar initiative without suffering real economic harm. Moreover, by picking their fights, U.S. negotiators will be more successful in those that they choose to pursue.

Just as on the domestic front, technology strategy will need to be one piece of a broader international puzzle, lest policymakers try to do too much with it and inevitably fail. Yet unlike cap-and-trade and robust regulation at home, there is essentially no chance of revival for robust global treaty efforts complete with strict targets, timetables, and sanctions for noncompliance any time soon. Fortunately, there is also less need. Countries' decisions about emissions have always been much more about domestic interests than foreign policy. A less formal approach that focuses on coordinating policies across borders, already under way as the result of some modest progress at the global climate talks, as well as innovative efforts to coordinate technology promotion such as the Glean Energy Ministerial (GEM) process, may be the best that is possible in the near future. More robust international efforts will eventually be required, but for now, maximizing room for domestic policy development, including through the right approach to technology, is the most important thing that can be done.

This approach to policy may leave those who worry most about climate change cold. When faced with a massive problem, people naturally grasp for an all-encompassing solution that promises salvation. Yet such schemes invariably reveal themselves to be mirages, and overwrought efforts to realize them too often backfire.

Wiser policy will involve modest moves forward on multiple fronts, including technology. It would be tragic if policymakers chose a different course and replaced one overburdened climate strategy with another.

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