AN INNOVATION-BASED CLEAN ENERGY AGENDA FOR AMERICA

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JUNE 2015

INTRODUCTION

Addressing global climate change requires clean energy technologies that are cost- and performance-competitive with fossil fuels without subsidies. Characterized by carbon prices, subsidies, and mandates, the dominant clean energy policy approaches in the United States and internationally are not likely to meet this goal. Only a cohesive and aggressive innovation strategy can produce the needed and rapid development of affordable clean energy options the entire world wants to purchase. This report discusses the dominant climate policy paradigm and why its supporters largely ignore innovation. It then argues for strategic investment and policy reforms focused on energy innovation. In particular, the report makes the following strategic investment and policy recommendations to reform the U.S. energy innovation ecosystem:

- Increase support for early-stage research by tripling appropriations for energy-related programs and divisions at the National Science Foundation (NSF) to $1 billion annually.
- Increase the Advanced Research Projects Agency-Energy's (ARPA-E's) budget to $1 billion annually.
- Double the budget for the Department of Energy (DOE) Energy Innovation Hubs.
- Increase funding for the DOE's Office of Energy Efficiency and Renewable Energy (EERE) to at least $2.5 billion per year.
- Expand the research and development (R&D) tax credit from 14 percent to 30 percent to spur private sector R&D investment.
- Pass the American INNOVATES Act of 2015, introduced by Senators Coons and Rubio, to enhance the "innovation enterprise" of the National Labs.
- Phase out existing energy production tax credits, and institute a new permanent, technology-neutral tax incentive to support emerging clean energy technologies from demonstration through early commercial scale-up, upon which the credit sunsets for that technology.
- Raise royalty rates on onshore leases as well as increase fees on unproductive acres for both onshore and offshore leases to raise at least $1 billion per year to fund a dedicated Energy Innovation Trust Fund dedicated fund to support clean energy research and development.
- Institute a $15 per ton carbon tax on upstream, combustible, non-feedstock fuel sources; direct 85 percent of revenues to pay for lowering the effective U.S. corporate tax rate; and allocate the other 15 percent to an Energy Innovation Trust Fund.

WHY CLIMATE CHANGE ADVOACTES IGNORE INNOVATION

For decades, the world has approached the problem of climate change with an attitude *Atlantic* contributing editor Charles C. Mann describes as akin to "self-flagellating asceticism," in which consumers are expected to consume less, reuse more, and buy clean energy even if it costs more.[1] Many city, state, and even national governments approach climate change with this ascetic attitude, choosing to impose higher energy costs on their citizens and businesses, hoping they will choose a "hair shirt" for themselves for the good of the entire planet.

Despite only a minute share of the global population making this ascetic choice, the belief that citizens will voluntarily accept pain now for gain later (or pain here for gain everywhere) drives climate policy. Often the loudest voices are those with the extra income to afford the "luxury goods" of a Tesla car, wind energy from their electric utility, and carbon offsets for their international vacation. While early adoption of these technologies by those with the necessary means has undoubtedly advanced the state of clean energy in the United States, clean energy technologies are still competitive with fossil fuels only in niche markets and usually with the aid of government subsidies. As long as clean energy technology costs more, on the whole, people and companies will make the comfortable choice and buy dirty energy. But when clean energy is cheap, people will buy it, and, with innovation, it will become significantly cheaper than dirty energy, not only reducing carbon emissions, but dramatically increasing global energy use. Indeed, the goal should be to reduce carbon, not energy use. We want the world to be more comfortable by using more energy, especially the billions of people in the world who are energy poor.

This gets to the heart of the matter. While it is rarely characterized as such, the climate challenge is first and foremost a technology problem, which cannot be solved without significantly better clean energy technologies. With the global population expected to grow by over 40 percent and per capita income to grow by over 125 percent in the next 35 years, currently proposed solutions—voluntary energy conservation, energy conservation regulations, carbon prices, "binding" commitments to reduce carbon emissions, clean energy deployment incentives, and even calls for negative GDP growth—will not work. To cut global greenhouse gas emissions in half by 2050 will require an 84 percent reduction in the "dirtiness" of every unit of energy consumed.[2] Given this challenge, energy conservation and subsidizing expensive clean technologies is like bailing out a leaky boat with a bucket. A bucket won't do it; we need to patch the boat. That won't be possible without massive increases in the use of zero-carbon energy technologies, and the 7.2 billion people on the globe will not switch until those technologies are cheaper than fossil fuel energy. Despite the claims to the contrary, clean energy technologies are neither performance ready nor cost effective enough for citizens to adopt them voluntarily around the world.[3]

How do we get needed clean energy innovation? The prevailing view holds that if we just put a price on carbon, the workings of the free market will enable low-cost, high-quality clean energy to magically emerge. There are two problems with this view. First, politics limits how high carbon taxes can go. Second, even if they were set very high, taxes alone won't solve the problem. As the Information Technology and Innovation Foundation (ITIF) showed in *Inducing Innovation: What a Carbon Price Can and Can't Do,* gas taxes more than double the price of carbon-based fuel in many European nations, but these nations still have very few electric cars.[4] Drivers there might have smaller cars or use cars less, but with rapid global growth, slightly lower rates of driving won't solve the problem. Why has this extremely high "carbon price" not spurred development of better electric cars with batteries that give real range at an affordable price? As ITIF demonstrated, breakthrough technologies have never been generated through

price signals. We didn't develop computers because the price of carbon paper for typewriters increased but because we needed to break the Axis countries' codes to win World War II. And after that, we needed computers to track missiles during the Cold War. In other words, we developed computers because we decided we needed them, and government funded the research to make them possible. Then the private sector took the lead and brought them the rest of way to market. The process will have to be the same for clean energy.

Some climate advocates give lip service to the importance of innovation, but for most of them, it is "deploy, deploy, deploy."[5] In other words, they don't seem to believe significantly better clean energy technologies are needed; they think we just need the political will to subsidize or force adoption of available clean energy technology. Their denial comes in part because they fear that acknowledging just how expensive clean energy really is will give ammunition to those opposed to taking action. But opponents already claim clean energy is too expensive, so why not admit the truth and push for effective policy that will lower true costs in the long run? Advocates also rightly see this as a crisis, and in any crisis you don't wait around for solutions to be developed, you act now. Yet pushing deployment of expensive clean technologies while ignoring the need to develop breakthrough cheap technologies is like bailing out a boat with a bucket, instead of patching the holes with zero carbon technologies.

Some "deploy, deploy, deploy" advocates justify their lack of support for innovation policy by claiming that if we can deploy enough technology now, economies of scale will drive down the cost enough to make it affordable without subsidies. This sounds good in theory; however, recent academic research has found evidence suggesting that policy reliance on deployment subsidies can result in "lock-in" of inferior technologies,[6] and also that scale effects can only lower costs so much if based on inferior technologies. No matter how far down the cost curve you go for existing technologies, the curve doesn't get below the fossil fuel curve. For example, no matter how many lithium batteries you make, they will never be good enough—without technological improvement—to cheaply and effectively power automobiles. To make clean energy cheaper than dirty energy, we must apply innovation to create a completely new and lower cost curve.[7] Then and only then will scale drive cost down and bring the improvements needed.

Finally, many, if not most, climate advocates have a limited view of innovation, seeing it as high-risk strategy that, given the seriousness of the problem, we can't take a chance on. This is grounded in the ill-conceived notion that innovation is something that simply happens, and is usually attributed to a combination of circumstances involving a single but prophetic inventor, the grace of the private sector, and some luck. Better to use the tried and true "bucket" to bail out the boat, rather than patch the boat. There are two problems with this logic. First, as noted above, it's impossible to put out the fire without the fire hose. Second, after a half-century of study, we know enough about the innovation process and innovation policy to adequately design clean energy innovation policies that will significantly increase the likelihood of developing the fire hose. Perhaps the fire hose can never be developed: The physics involved in storing or generating energy in clean ways may be such that we can never do better than fossil fuels. If that turns out to be true, then we will have to accept the fact that we will not decarbonize the planet and instead must focus efforts on adaptation. But we will not know if we don't try.

Instead of browbeating consumers to cut energy use and hoping national governments will sign treaties in which they promise they will cut carbon emissions or institute carbon taxes (but in reality likely will not), it's time for a fundamentally new approach. Climate change policy in the United States and internationally should be focused on policies that accelerate the development of zero-carbon technologies that are as cheap—or cheaper—than dirty fuels.

The nation is far from where it needs to be in terms of cultivating such an energy innovation ecosystem to mitigate climate change. The policy reforms and increased investments suggested below offer opportunities for Congress and the next administration to improve the U.S. energy innovation ecosystem by defining its existing elements and identifying potential points for improvement and enhancement.

The United States has been the leader in most of the major technological innovations of the last half-century, and so has contributed more to the improvement of global welfare than any other nation in history. It is both our destiny and obligation to once again bring the innovative genius of America to bear on a central challenge of the 21st century, climate change. But we won't do that by relying on the market alone. Meeting this challenge, like many past innovation challenges, requires smart public policies, and most importantly, increases in investment in clean energy technological research to produce the breakthroughs required to solve climate change.[8]

STATE OF THE U.S. ENERGY INNOVATION ECOSYSTEM

Throughout the country's history, innovation has been the key driver of economic growth and competitiveness. Since the United States developed strategic and committed priorities for basic and applied science, engineering, and technology development over a half-century ago, the country has led the world in technology breakthroughs in health care, transportation, telecommunications, agriculture, manufacturing, and energy. These breakthroughs have driven economic growth for decades and improved quality of life for past and present generations, reflecting the "virtuous cycle" nature of innovation to connect institutions and policies across technology development stages to enable falling technology costs and prices and rising aggregate economic output and productivity.

But when it comes to developing a robust clean energy innovation policy, the U.S. system is nowhere near where it must be. The United States invests about $1 billion less on energy innovation today than in the mid-1990s, despite urgent and escalating scientific and public concerns about the potentially damaging effects of climate change that may be realized in the next half-century.[9] Faced with growing deficits and divergent views of whether climate change is real, the country's energy research, development and demonstration (RD&D) programs have become a battleground, resulting in investments amounting to only one-third of what is estimated as necessary to accelerate breakthroughs in clean energy technologies.[10] The debate in Congress over federal funding to support innovation is mostly waged in battles over appropriations legislation, and significant effort has been spent during the last few years on trying to "save" programs from elimination, rather than on growing the ecosystem with further investment in existing and new programs.

Reflecting the mantra of climate advocates of deploy, deploy, deploy, coupled with lobbying by the current clean energy industry, the lion's share of federal support for clean energy has been on subsidizing the deployment of existing technologies. Between fiscal years 2009 and 2012, 71 percent of direct federal investments in clean energy went to deployment; during the same period, public investment in deployment nearly tripled, while investment in RD&D projects either remained steady or declined.[11] The sad reality is that deployment has many advocates (some ideological, some interest-based); development has few. Subsidizing the deployment of expensive technologies detracts both financially and practically from the effectiveness of earlier stage RD&D, and as noted above, paying to deploy more "patches" will never be enough to patch all the holes.

It's time for a new approach to climate change in America, one built around innovation. Let the rest of the world dabble with regulatory mandates to deploy high-cost technologies. Let America lead in developing

the next clean energy revolution. In theory this should be an area where we could develop some modicum of political consensus. Republicans, rightly so, are skeptical of regulation or taxes that would raise energy prices and reduce energy use in ways that would limit our standard of living and competitiveness. But with climate change real and the effects only intensifying, at some point Republicans will have to design a strategy for handling it, if for political reasons alone. Democrats worry about the fate of the planet, but given the unwillingness of most Americans to wear the hair shirt of expensive clean energy, the likelihood that voters will support measures such as cap and trade, a sizeable carbon tax, or other regulatory measures is slim at best. Voters are much more likely support an innovation-based climate strategy, which could have three beneficial outcomes. First, and most importantly, it could, if successful, drive down clean energy prices and enable global decarbonization. Second, it could position the United States as a leader in clean energy technology, boosting U.S. competitiveness. Third, it would enable the United States to meet global expectations of lowering emissions without hurting the competeveness of our energy intensive sectors.

This strategy requires two key areas of policy action. The first is to increase federal support for clean energy R&D. The second is to reform programs and institutions to spur the transition of clean energy discoveries from lab to market.

FEDERAL INVESTMENT IN CLEAN ENERGY-RELATED RESEARCH AND DEVELOPMENT

Public investments in research and development form the base of support for the innovation ecosystem by funding foundational basic science through proof-of-concept designs.

Boost Clean Energy Science at the National Science Foundation

The development of truly breakthrough technologies in areas like energy storage and solar conversion require advancements in science.[12] Government can't predict or even direct the nature of that science, but it can identify the key areas of science most likely to lead to these breakthroughs and increase funding accordingly. A key place to start is the National Science Foundation. With an annual budget of approximately $7 billion, NSF funds projects that range the gamut on energy-related basic science, including those that advance knowledge about the growth of nanocrystals and the development of ultra-lightweight carbon fiber materials.[13] NSF provides integral support for basic energy science, including divisions in chemical, bioengineering, transport systems, chemistry, and materials research. NSF funds thousands of projects with implications for improving and developing new energy technologies. But it can and should do more.

Congress should triple NSF funding for energy-related research to $1 billion annually. This increased funding should not go to studying climate change, but to advancing the science underpinning clean energy technology breakthroughs, especially generation and storage. At the same time Congress should charge the National Academy of Sciences (NAS) to undertake a study of the kinds of scientific advancements needed to drive transformational clean energy breakthroughs.[14] The findings of this study should guide the internal allocations of NSF funding for clean energy science.

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Advanced Research Projects Agency-Energy (ARPA-E)

While early stage basic research is needed to build the knowledge base for clean energy breakthroughs, we also need more high-risk directed or applied R&D. The best agency supporting this is the Advanced Research Projects Agency-Energy, the Department of Energy's breakthrough energy technology program, which invests in risky, next-generation clean energy technologies that could fundamentally change the energy market.[15] Modeled after the Department of Defense's Defense Advanced Research Projects Agency (DARPA) program, which has long invested in risky, potentially breakthrough technologies, ARPA-E invests in transformative technologies that allow scientists to re-envision entire energy systems. Unfortunately, ARPA-E is significantly underfunded. Its FY2013 budget is set at $280 million, not even 30 percent of the $1 billion initially proposed by the National Academies of Science and the President's Council of Advisors on Science and Technology.[16] Furthermore, ARPA-E's budget has been plagued by uncertainty. It was initially funded at $400 million through the stimulus package in 2009, only to be cut through budget appropriations to $200 million in 2010. Its funding dipped further to $181 million in 2011, but was increased as part of the FY2012 budget Omnibus appropriations to $275 million, and investment in the agency has stayed relatively consistent since then.[17]

ARPA-E is the strongest high-risk, high-reward research program in the federal government for clean energy technology, and its budget should reflect this reality; over a period of three to four years Congress should ramp up ARPA-E's budget to $1 billion annually.

Expand Funding for Energy Innovation Hubs

DOE's Energy Innovation Hubs are interdisciplinary, goal-oriented, integrated centers that bring together researchers from academia, industry, and the National Laboratories to work toward meeting ambitious and targeted technology goals with industry applications in mind. DOE funds four Hubs at $25 million per year: the Critical Materials Institute, the Joint Center for Energy Storage Research, the Joint Center for Artificial Photosynthesis ("Fuels from Sunlight"), and the Consortium for Advanced Simulation of Light Water Reactors ("Nuclear Energy Modeling and Simulation"). The Hubs connect scientists and industry to enable fast technology transitions from the lab into the market, and this goal-oriented mission keeps the Hubs focused on the future.

"Congress should increase funding for the Hubs to at least $200 million per year, in order to expand existing Hubs as well as establish new ones."

Office of Energy Efficiency and Renewable Energy at DOE

DOE's Office of Energy Efficiency and Renewable Energy (EERE) invests in research to develop next-generation transportation, energy generation, and efficiency technologies. EERE serves as the "connective tissue" of the Department of Energy. Its Hubs leverage research conducted through EERE to reach technology milestones; the Energy Frontier Research Centers inform EERE research priorities; and cross-cutting programs within EERE connect interdisciplinary research throughout traditionally separate industry sectors. EERE also funds DOE's Advanced Manufacturing Office, which partners with industry, small business, universities, and other stakeholders to advance emerging manufacturing technologies that reduce climate and energy impacts while strengthening the manufacturing sector to increase national competitiveness.

Appropriations to EERE are frequently significantly lower than proposed in presidential budget requests—FY2015 Omnibus appropriations were 15 percent below the FY2015 presidential request for EERE, and in

previous years the difference has been even more significant. As EERE is the connective force among many of DOE's innovation institutions, funding should be increased from approximately $1.9 billion to at least $3 billion per year to successfully accelerate and integrate energy RD&D programs at DOE.

Expand and Increase the R&E Tax Credit

The Research and Experimentation (R&E) Tax Credit is a key way the federal government supports private-sector R&D activities. The IRS allows the credit for qualified expenditures in the United States, which primarily include the wages paid to employees engaging in qualified research activities, 65 percent of the fees paid to external contractors for the performance of qualified research, and supplies used in conducting qualified research (but not equipment used in research). Scholarly research has shown that the credit is an effective tool for spurring additional R&D (with one dollar of credit stimulating at least $1.20 of R&D), and that it also responds to a significant market failure: companies' inability to capture the full societal benefit of their research.[18] As the Congressional Joint Committee on Taxation wrote, "Although an individual business may find it profitable to undertake some research, it may not find it profitable to invest in research as much as it otherwise might because it is difficult to capture the full benefits from the research and prevent such benefits from being used by competitors."[19]

To spur private sector R&D investment, including in clean energy, while at the same time reducing the effective corporate tax rate to make the U.S. economy more globally competitive, Congress should increase the Alternative Simplified Credit rate from 14 percent to 30 percent.[20]

REFORMING TECH-TO-MARKET AND DEPLOYMENT POLICIES

Build Better Connections Between the National Labs and the Market

The Department of Energy's Office of Science serves as a major hub for energy science research, exploring research in high-energy physics, nuclear energy, and chemistry to develop new materials and biochemistries for major advances in battery technologies and fuel cells. A critical source of energy innovation, Office of Science investments support the construction and operation of its user facilities and maintain the U.S. National Labs system. The National Labs system, created in the 1940s, addressed some of the most significant scientific and innovation challenges of the time, and today the Labs continue to be a source of technology development and discovery. However, the Labs' connection to the market is weak, and institutional adaptations would make the Labs more effective and efficient.

To enhance the "innovation enterprise" of the National Labs, Congress should pass the American INNOVATES Act of 2015, introduced by Senators Coons and Rubio. The bill would integrate the management of DOE's science and energy programs to create a vertically integrated research enterprise, direct DOE to implement best practices to improve operations and management across the National Lab complex, allow the Labs to partner more effectively with the private sector to create new technologies and enhance technology commercialization, allow DOE more flexibility to support applied research and development activities conducted by universities and nonprofits, and give startups more access to cutting-edge facilities at the Labs. The legislation would also provide the Labs with the opportunity to increase collaboration between government and university scientists with researchers from the private sector, including allowing the Labs to charge a market rate for all proprietary research, rather than only allowing full-cost recovery. Additional fees raised this way could be directed toward incentives for Lab management contractors, additional Lab overhead expenses, and/or the taxpayer as necessary per the Lab management and operation contracts.[21] The legislation also extends DOE's pilot program—

Agreements for Commercializing Technology (ACT)—which would give the Labs greater ability to partner with industry more quickly and efficiently.

"To enhance the "innovation enterprise" of the National Labs, Congress should pass the American INNOVATES Act of 2015, introduced by Senators Coons and Rubio."

Transform Tax Credits for Deployment to Innovation Incentives

Congress has created energy tax credits to spur clean energy deployment. But these could do more to drive innovation rather than more deployment of existing technologies. For example, the Wind Production Tax Credit (PTC) has offered the same value per kilowatt hour since 1992, making it a guaranteed subsidy for any wind technology, regardless of its future cost reduction and performance improvement potential.[22] Environmental groups argue the PTC is a key public investment for a nascent industry competing against entrenched fossil fuels that contribute to global warming. Yet, the PTC no longer supports breakthrough wind innovation as it did in the 1990s when most wind turbines were truly new technology. Today's developers are more likely to choose commercial scale wind turbines that still aren't cost competitive, especially when energy storage costs are taken into account, rather than invest in riskier, next-generation technologies.

Congress should make the wind PTC and the solar Investment Tax Credit (ITC) drivers of innovation and at the same time eliminate conventional fossil fuel tax subsidies, such as oil and gas depletion allowances, drilling cost expensing, and production tax credits.[23] To do that Congress should implement a permanent, technology-neutral tax credit that only supports emerging energy technologies looking to scale into the marketplace. A good tax structure to start with is the Energy Innovation and Manufacturing Tax Credit (EIMTC) proposed by Will Coleman of OnRamp Capital. The EIMTC would only support next-generation clean energy from demonstration until it reaches commercial production scale, at which point the line of credit would sunset and the technology would have to compete in the marketplace. Clean technologies already at commercial scale, such as natural gas and many wind and solar technologies already prevalent in the market, would not be eligible. The result is a flexible, long-term tax credit that fosters and accelerates clean energy innovation and provides long-term policy certainty.

"Congress should make the wind PTC and the solar Investment Tax Credit (ITC) drivers of innovation and at the same time eliminate conventional fossil fuel tax subsidies, such as oil and gas depletion allowances, drilling cost expensing, and production tax credits."

RAISING REVENUE TO FUND CLEAN ENERGY INNOVATION INVESTMENTS

Budgetary and political disputes in Congress, particularly in recent years, have resulted in consistent appropriations threats to key energy innovation programs. Investing more in clean energy R&D can help make America more energy independent, can lead to the growth a robust and globally competitive clean energy industry, and of course, can help reduce carbon emissions while actually saving money. But getting this technology will require increased federal support, in part to pay for the increased R&D tax credit and for increased federal support for clean energy research and development. There are two sources of funding Congress should consider to pay for these expanded investments.

Create an Energy Innovation Trust Fund Supported by Drilling Fees

The federal government collects drilling revenues on public lands through bonus bids in auctions, rents during times of exploration, and royalty rates when the tract of land is producing oil or gas. Congress distributes the majority of the revenue from oil and gas drilling on public lands to the U.S. Treasury's General Fund. To prioritize energy innovation as a solution to climate change mitigation and economic growth, Congress should raise royalty rates on onshore leases as well as increase fees on unproductive acres for both onshore and offshore leases to raise at least $1 billion per year to fund an Energy Innovation Trust Fund.

To fully support an Energy Innovation Trust Fund, Congress should expand safe and environmentally manageable drilling on federal lands such as in the Outer Continental Shelf—which is currently prohibited by an administrative moratorium—while also implementing new fees on all unproductive acres and raising royalty rates for onshore leases to at least the level of the lowest royalty rates for offshore leases. Increasing fees and boosting onshore royalty rates will immediately generate enough new revenue to fully fund high-risk, high-reward energy research at the ARPA-E at the recommended level of $1 billion per year. Expanding oil and gas drilling on some federal lands, will not generate a large amount of revenues immediately, but the levels could grow over time.[24]

"Congress should raise royalty rates on onshore leases as well as increase fees on unproductive acres for both onshore and offshore leases to raise at least $1 billion per year to fund an Energy Innovation Trust Fund."

Institute a Carbon Tax

Many climate advocates see putting a price on carbon as the silver bullet that will send the right market signals to reduce CO2 emissions automatically and dramatically. But as discussed above, while a carbon price will help, it will help only at the margin. Combining a carbon price and robust clean energy research and development support could be a powerful combination.

Opponents of instituting a carbon price express two main worries. The first is that it will harm U.S. competiveness. The second is that it will raise government revenues and spending. Both concerns can be addressed by instituting a carbon price where most of the revenues are used to lower the corporate tax rate. Congress should implement a 15-year, $15 per ton carbon tax on upstream, combustible, non-feedstock fuel sources. Roughly 80 percent of the tax revenue should be recycled into the economy by creating new and expanded business tax credits for R&D, workforce training, and capital equipment investments. Roughly 15 percent of the carbon tax revenue should be directed into a dedicated Clean Energy Innovation Trust Fund that would support energy innovation programs across the government.[25] This would raise approximately $13.5 billion per year.

"Roughly 15 percent of the carbon tax revenue should be directed into a dedicated Clean Energy Innovation Trust Fund."

CONCLUSION

Addressing global climate change requires clean energy technologies that are cost- and performance-competitive with fossil fuels without subsidies. Yet, the dominant energy policy approaches in the United States and internationally, characterized by carbon prices, subsidies, and mandates, are ineffective in meeting that goal. Only a cohesive and aggressive energy innovation strategy can result in the needed and rapid development of affordable clean energy options the entire world wants to purchase.

If the United States commits to innovation in its energy policy with the proper budget priorities, we have an opportunity to lead the world in developing and adopting clean energy technologies that are affordable and effective in reducing carbon emissions.

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Dr. Robert Atkinson is the founder and president of the Information Technology & Innovation Foundation, a Washington, DC-based policy think tank. He is also author of *Innovation Economics: The Race for Global Advantage* (Yale, 2012); *Supply-Side Follies* (Rowman and Littlefield, 2006); and *The Past and Future of America's Economy: Long Waves of Innovation That Power Cycles of Growth* (Edward Elgar, 2005). Dr. Atkinson received his Ph.D. in city and regional planning from the University of North Carolina at Chapel Hill in 1989.

ABOUT CCEI

The Center for Clean Energy Innovation is a Washington, D.C.-based think tank dedicated to designing, advocating, and advancing cutting edge energy innovation policies to address global climate change, increase economic growth, and provide universal energy access. Founded in 2014, CCEI is a non-partisan organization that accepts climate change as an innovation challenge at heart, focusing on energy RD&D policy, smart deployment, clean technology trade policy, STEM education and training, and advanced manufacturing at the state, national, and international levels.

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