The Logic Chain to an Effective Global Clean Energy Policy

By Matthew Stepp &
Megan Nicholson

ITIF
The Information Technology
& Innovation Foundation

THE GLOBAL CLIMATE AND ENERGY POLICY DEBATE: A CHAIN OF LOGIC

For almost thirty years the world has debated how to address climate change. The results have not been good. Global greenhouse gas emissions continue to increase and clean energy technologies remain a small share of the global energy mix.[1] Many advocates argue the lack of tangible climate progress is due to a lack of political leadership. Whether it is blaming the United States' inability to pass a cap-and-trade plan or discrediting developed nations' half-hearted attempts to strike a global climate accord, the dominating narrative is the same: weak global policy attempts, especially by the United States, are holding the rest of the world back.[2]

While political ideology has certainly shaped the climate change debate, the problems are actually much deeper. The central policy solutions the world is pursuing are not globally feasible or enough to make a significant difference in mitigating climate change because clean energy technologies are still too expensive or inadequate in performance. For instance, carbon pricing aims to increase the price of fossil fuels to allow clean energy to compete, but it has failed to gain traction in the U.S. because of the potential economic impacts of higher energy prices. Nonetheless, its impact on carbon emissions has been small in places that have implemented a more economically palatable carbon price, such as the European Union.[3] The world is simply not willing to trade economic growth and higher living standards for more expensive energy and deep carbon reductions. When it has tried, the carbon price has been so small that it is ineffective at facilitating the clean energy transition it was created to address.[4]

As an alternative to carbon pricing, many countries have turned to government subsidies and mandates. Policies such as tax incentives for clean energy and regulations on power plants, buildings, and vehicles aim to provide clean energy technologies with a market advantage against entrenched oil, coal, and natural gas industries. These approaches have had some modest successes, such as Germany's solar power subsidies and U.S. wind energy tax incentives, but clean energy deployment is still small compared to how much is needed to decarbonize the world's energy system.[5]

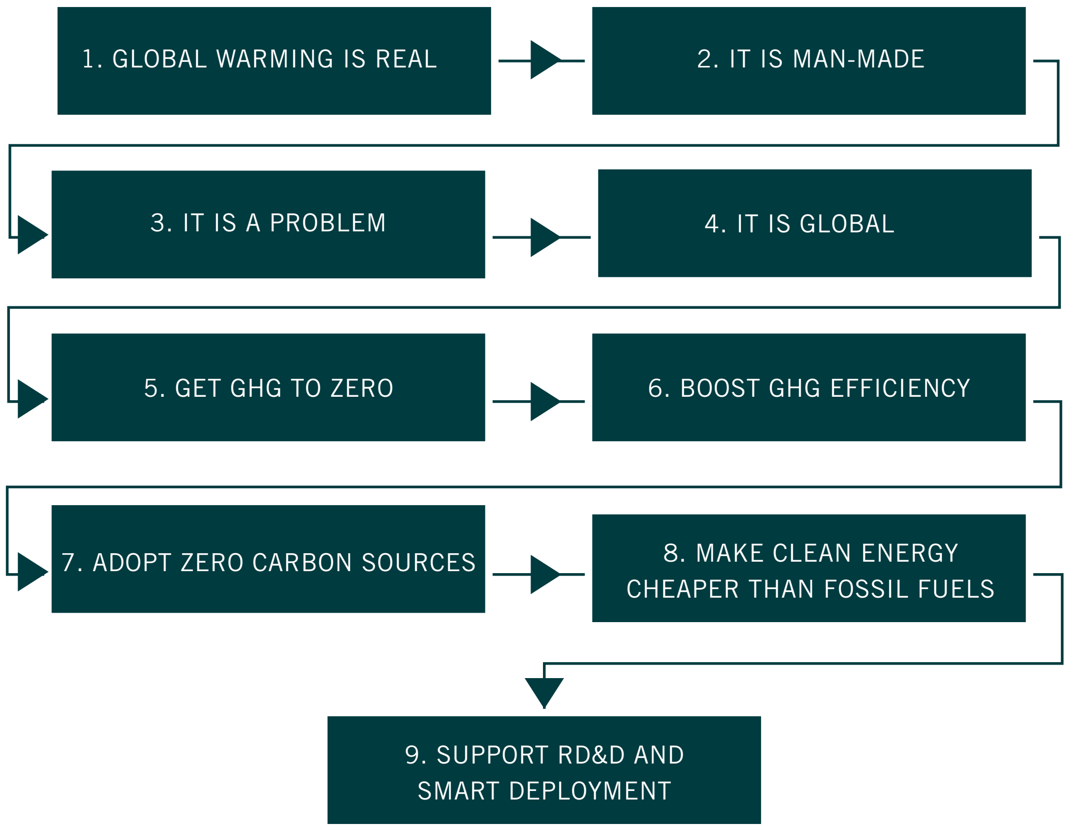
Even more problematic are the scalability issues associated with subsidies and mandates. To deploy more expensive, current-generation clean energy technologies, subsidies need to increase or regulations need to be tightened. Yet more generous subsidies cost more for governments, and more stringent regulations usually require consumers to pay higher energy bills.[6] Not only does this limit the political appeal of more aggressive clean energy policies in developed countries, it limits the implementation of these expensive policies in developing countries that cannot afford them.

The world has failed to address global climate change during the last thirty years not only because of the politicization of the debate, but also because advocates and policymakers are pursuing ineffective policy solutions. The global climate policy narrative misses an important caveat: clean energy technologies are not ready to serve as the dominant energy source for seven billion people and counting. Innovation is needed to drive down costs and increase performance compared to cheap fossil fuels. Unfortunately, today's policy choices are not adequately equipped to advance clean energy innovation.

This report presents a logic chain of nine steps for addressing global climate change through innovation. It works through a step-by-step series of assumptions that link the globally serious climate challenge with the need for an aggressive clean energy innovation policy strategy. For the library of ITIF's clean energy policy ideas and reports, visit www.itif.org.

Energy INNOVATION LOGIC CHAIN

ONLY AN AGRESSIVE INNOVATION POLICY BASED ON SIGNIFICANTLY INCREASED SUPPORT FOR RD&D AND SMART DEPLOYMENT WILL EFFECTIVELY DRIVE ENERGY INNOVATION.



STEP 1. GLOBAL WARMING IS REAL

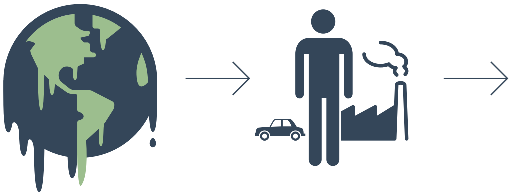
Establishing policies that effectively address climate change requires, first and foremost, widespread acknowledgement that global warming is real. Counter to the false debate often portrayed in the media, the global climate is unequivocally changing. It is certainly true that day-to-day temperatures fluctuate depending on the location and weather, but taken as a whole, there is near universal acceptance among the climate science community that the Earth is warming.[7] The most reputable climate data sources in the world and every official national and international scientific institution agrees that global average temperatures are increasing and have already risen by almost 1°C since 1900.[8]

There are still those that see little cause for alarm because the Earth's climate has changed before and will likely continue to change into the future. The problem is that the Earth's climate has never changed this much, *this fast*. Over half of the recorded warming has occurred in the last 35 years.[9] Global warming has accelerated in the past 15 years because the oceans are heating up at an accelerated rate.[10] Make no mistake about it—global warming is real and it is accelerating with each passing decade.

STEP 2. GLOBAL WARMING IS HUMAN-CAUSED

The next step to positively affecting climate policy is to acknowledge that global warming is caused by human activity. One of the most enduring public science debates is whether or not global climate change is the result of human actions, such as burning fossil fuels. Decades worth of scientific analysis, data collection, and modeling of the Earth's climate system have increasingly pointed to humans' role in global warming. In 2013, the Intergovernmental Panel on Climate Change (IPCC)—a United Nations organized scientific body representing climate scientists from 195 countries—announced it is 95 percent certain more than half of the warming seen in the last century is due to human activity—an increase from 90 percent certainty a decade earlier.[11]

While natural factors such as volcanic eruptions, changes in the sun, and decadal variability in Earth's climate system also cause climate change, those factors are not enough to explain the rapid warming seen in the last half century. The main culprit has been the drastic increase in greenhouse gases in the atmosphere of which the most prevalent gas, carbon dioxide, has reached a concentration of almost 400 parts per million compared to a pre-industrial range of 260 to 280 parts per million.[12] This acceleration mirrors increased human activities that emit greenhouse gases, such as transportation and electricity generation. And concentration levels continue to increase as more of the global population gain access to energy and drive cars, and as industries ramp up production to supply products and services to a growing population.

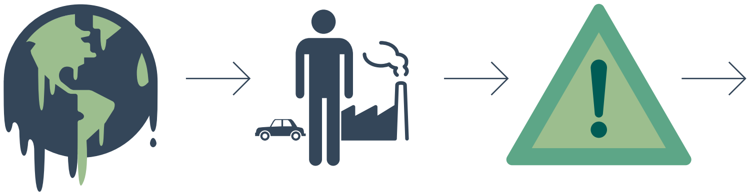


STEP 3. GLOBAL WARMING IS A DANGEROUS PROBLEM

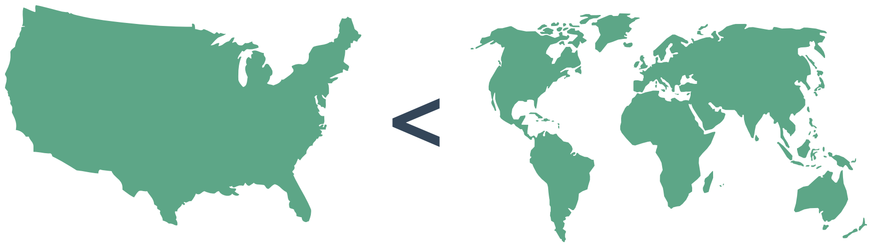
Even if there is widespread recognition that global warming is real and human-caused, the action needed to solve it won't happen unless there is also widespread acceptance that global warming is a serious problem.[13] The fact is that over time, as global concentrations of greenhouse gases increase so will global air and ocean temperatures, resulting in serious, and potentially dangerous, impacts.

The best scientific estimates indicate that our current emissions trajectory poses a significant risk of eliminating many unique ecosystems including coral reefs, large swaths of forests, small island communities, and arctic habitat.[14] Extreme weather events like floods, heat waves, droughts, and wildfires will become much more frequent and have greater regional impacts throughout the world. Global agriculture will be directly affected, resulting in smaller yields and annual food production disruptions.[15] Less economically developed populations and those in lower-lying regions will be most vulnerable, and hundreds of millions of people will potentially be adversely affected by events like coastal flooding, saltwater infiltration into agricultural lands, and sea level rise. Climate models also point to a more-likely-than-not probability that even greater impacts will result from feedback mechanisms such as permafrost and ice sheet melting, which would unleash further warming.[16]

In other words, global warming presents a future world very different—and potentially much more dangerous—than the one humans live in today. The severe, rapidly accelerating, and human-caused nature of global climate change characterizes itself as an immediate social, economic, and political issue that requires aggressive and strategic human action.



STEP 4. IT'S GLOBAL WARMING NOT JUST "AMERICAN WARMING"



Even if it is generally accepted that global warming is a problem, getting to an effective solution requires recognizing that climate change is, in fact, a global problem. Some advocates and policymakers support state or national policies to "solve" climate change because the challenge is more manageable. However, climate change is a global phenomenon requiring *globally* impactful solutions. Carbon dioxide knows no boundaries. U.S. greenhouse gas emissions don't warm particular cities, states, or nations—they warm the planet. Therefore cutting emissions only in individual countries will have little long-term impact on the larger challenge.

The United States, for example, is implementing national policies by limiting power plant greenhouse gas emissions through EPA regulations and subsidizing the deployment of current-generation wind and solar projects. While there are surely benefits to an individual country's' implementation of these policies, such as reduction of particulate pollution, it will have little impact on global climate change in isolation. Most developing countries are not able to afford significant subsidies for clean energy or higher energy prices resulting from stringent regulations. Current-generation clean energy technologies are simply too expensive and performance-limited. Even China, which is investing significant public dollars in clean energy subsidies, continues to build coal plants to provide cheap energy access to its population.[17]

Finding national solutions to global climate change can also create *negative* feedbacks. For instance, China has implemented aggressive green mercantilist policies, such as export dumping and forced localization, to protect and bolster its clean energy industries and reduce its greenhouse gas emissions. Unfortunately, protectionist policies harm global clean energy innovation and actually limit the world's ability to address climate change.[18]

Instead, climate policies should focus on providing all countries cheap, clean energy alternatives—not just those able to afford more expensive clean energy.[19] Ultimately, the world will rapidly switch to clean energy when it is cheaper and better than fossil fuels in absence of subsidies, protectionism, and regulations. Policymakers in all countries should view their climate policies through the lens of what type of *global* impact they will have. Anything less does not address global warming to its full extent.

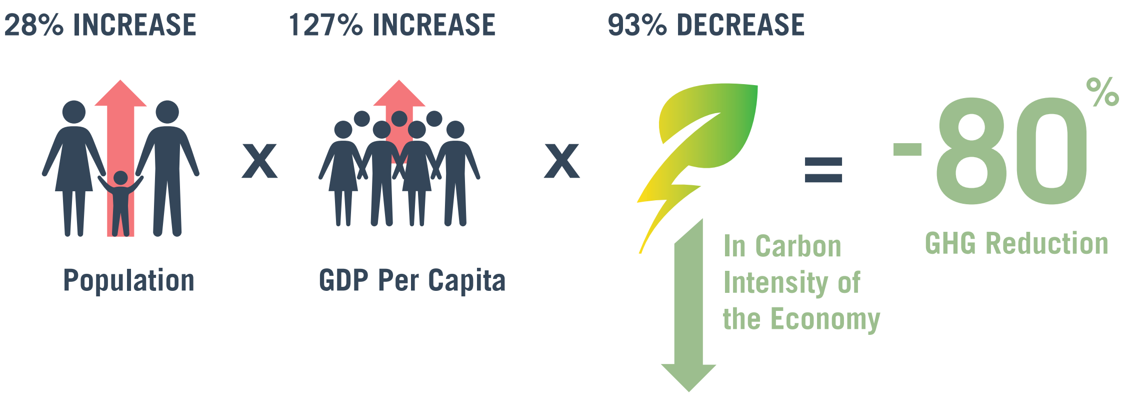
STEP 5. THE POLICY GOAL IS TO REDUCE GREENHOUSE GAS EMISSIONS TO ZERO

In addition to recognizing the *global* nature of climate change, solutions must also aim for the right emission reduction end-game. For some, this means coming to terms with the fact that holding total global warming to less than 2°C, a commonly adopted "line in the sand" drawn by many climate advocates, has become nearly impossible. In fact, conventional solutions built around this goal simply will not achieve the scale of reductions needed.

As recent research has shown, limiting the world to 2°C warming most likely requires reaching a peak in global carbon emissions in the next 5-10 years, followed by immediate reductions to near-zero emissions by 2050.[20] It is now fairly obvious that the lack of progress on global decarbonization has pushed this timetable out of reach. Even so, that 2°C limit constitutes a clear threshold below which global warming is "acceptable" and "safe" and above which it is "dangerous" has always been an arbitrary conceit. What constitutes "dangerous" climate change is a human value judgment, not a matter of precise science. Instead, we are now, as we have always been, left to act in spite of and because of this inherent uncertainty.

As we have learned from climate science, global greenhouse gas emissions must be reduced because climate change presents an immediately clear threat. Damaging climate impacts are likely already occurring even at today's levels of warming, and each degree of greater warming will intensify future impacts. Greenhouse gas emissions must therefore be reduced as quickly as possible to zero. Hurtling towards a 2°C warmer world and potentially beyond does little to change this fundamental calculus and the climate policy goal is the same: the world needs to implement climate policies that reduce greenhouse gas emissions as fast as possible.

STEP 6. GETTING TO ZERO EMISSIONS REQUIRES BOOSTING GREENHOUSE GAS EFFICIENCY



Getting to zero greenhouse gas emissions is not a simple task. The world can't simply turn off its industries, cars, and electricity—nor is it enough to only increase the efficiency of energy use.

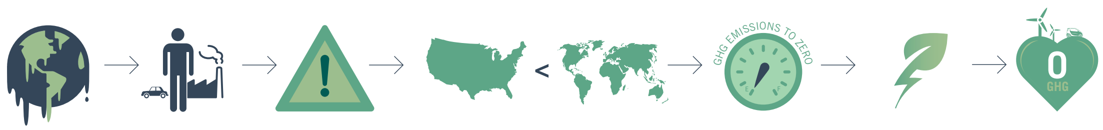
By 2040, global population is expected to grow by 28 percent, and global per-capita GDP is expected to grow by 128 percent within the same time frame, which will lead to even more energy use. To achieve the necessary 80 percent reductions in GHG emissions by 2040, the carbon intensity of the economy would have to fall by 93 percent.[21] In other words, the world would need to completely switch from petroleum-based fuels for transportation and heat, and immediately eliminate all coal and natural gas consumption, replacing it with nuclear energy or other renewable technologies. Future climate policies should match the severity of this reality.

STEP 7. SIGNIFICANTLY REDUCING CARBON INTENSITY REQUIRES ADOPTING ZERO-CARBON ENERGY

Considering the need for such significant decreases in carbon intensity necessary for adequate greenhouse gas emission reductions, replacing coal plants or gasoline cars with "cleaner" technologies rather than zero-carbon technologies will not be enough.[22]

Natural gas, for example, which many advocates peg as at least 50 percent cleaner than burning coal, is often discussed as an integral part of aggressive climate policies. But building out natural gas in lieu of coal plants—while having short-term pollution benefits—still will not lead to the decreases in carbon intensity necessary.[23] It potentially lends itself as a short-term "bridge fuel" to modestly reduce greenhouse gas emissions, but mitigating climate change requires policies that emphasize developing cheap zero-carbon energy sources.[24] Natural gas, by itself, is simply not a climate policy panacea.

While there are certainly other benefits to supporting "cleaner" energy technologies, climate policymakers should not fool themselves into viewing these options as long-term solutions. Even in cases where cleaner fuels are potentially a "bridge" to a zero-carbon future, ensuring that future requires policies that emphasize developing renewable energy resources.



STEP 8. ADDRESSING CLIMATE CHANGE REQUIRES CLEAN ENERGY TO BE CHEAPER, BETTER, AND UNSUBSIDIZED

To realize widespread adoption of zero-carbon energy, renewable technologies must be as cheap or cheaper than fossil fuels. Energy is largely a fungible commodity—there is no immediately tangible difference in the electricity coming out of your wall socket if it comes from a coal plant or a wind farm. The only immediate differences are cost and reliability. This means that the rate of adoption for new clean energy technologies is largely moderated by two principal factors: (1) The level of public tolerance for paying for the cost of cleaner energy in the form of higher energy costs, higher taxes to pay for subsidies, reduced economic welfare, or reduced energy access; and (2) the cost and performance competitiveness of clean energy compared to fossil fuels.[25]

As it stands today, clean energy technologies are expensive and only competitive with fossil fuels in niche markets, often with the help of government subsidies.[26] Without subsidies (and other incentives, like mandates), consumers' willingness to pay for more expensive clean energy is relatively low.[27] Moreover, today's clean energy does not provide the same level of performance as its fossil fuel competition, exemplified in limited range of electric vehicles or intermittency of solar and wind-based electricity. While subsidies (and even mandates) may be seen as the quickest way to deploy clean energy in the short-term, it is the equivalent of beginning a long-distance race by sprinting—you are eventually going to run out of steam.[28] Limited government budgets and consumer unwillingness to switch to more expensive or more limited energy technologies inherently constrain how far existing technologies can decarbonize the world, especially in lower-income nations.

As a result, simply subsidizing existing clean energy technologies more isn't necessarily going to lead to more global deployment. In the short term, reducing the *price* of clean energy through subsidies can make clean energy competitive with fossil fuels, but only artificially as long as the subsidies are in place and only in states or nations offering the subsidy. Reducing the cost of clean energy, while also increasing performance is the only way that consumers and industries around the world will voluntarily adopt zero-carbon energy sources.

STEP 9. THE ONLY WAY TO GET CHEAPER AND BETTER TECHNOLOGIES IS THROUGH STRATEGIC INNOVATION POLICY

Effectively addressing global climate change requires zero-carbon technologies that are as cheap and as efficient as fossil fuels. Generating those technologies, however, is easier said than done and requires much more effective innovation policy than provided by the subsidy, mandate, and carbon pricing strategies dominating today's climate policy debate. As the last century of technological development has shown, aggressive public policy and investment are key drivers of innovation. From gas turbines and shale natural gas to nuclear energy, government innovation policy can have dramatic impacts on supporting the development of zero-carbon technologies by fostering a comprehensive energy innovation ecosystem.

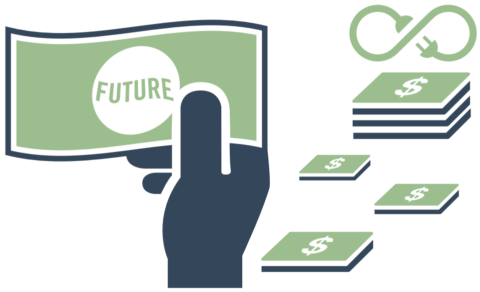
Historically, public investments in research and development (R&D) are fundamentally the most important part of an effective innovation policy, but by itself R&D is not enough. Effective clean energy innovation policy also means supporting innovation from basic science and R&D through testing, demonstration, and smart deployment incentives. Policy must support bridging technologies across the "Valleys of Death"—the phases in development between R&D and prototyping the first generation of a technology and the transition between demonstrating a new technology at scale and commercialization.[29] This support is crucial, particularly for new energy technologies competing against entrenched industries with a century worth of subsidy, regulatory, and infrastructure support.

Effective clean energy innovation should encourage strategic investments to drive breakthrough technologies instead of pursuing incremental improvements. Today's clean energy policies emphasize the deployment of existing renewable technologies, but significantly more emphasis on the entire energy innovation ecosystem—including research, development, demonstration, prototyping, and "smart" deployment of next-generation technologies—is necessary to drive costs down and performance standards up. Advocacy and policy support for critical public investments to support the full spectrum of the energy innovation ecosystem has waned in recent years and must be supported into the future. The key for encouraging breakthroughs in clean energy is not to pick a "champion" company or directly pursue a very narrow technology as the be-all solution. The key to effective clean energy policy is supporting a broad clean energy technology 'menu,' and then letting the market decide.

ENERGY INNOVATION POLICY RECOMMENDATIONS

FIFTEEN BILLION DOLLARS ANNUALLY

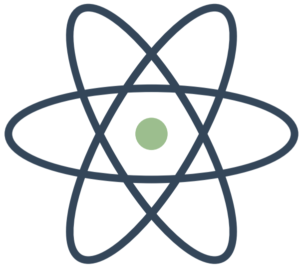
Significantly Increase Public Investments in Clean Energy RD&D
According to ITIF's Energy Innovation Tracker, the U.S. federal government invests roughly $5 billion per year in clean energy research, development, and demonstration (RD&D).[30] In comparison to other leading innovation challenges, clean energy is at the bottom of the list: the U.S. invests $9.5 billion annually in space exploration, $30 billion in healthcare research, and $70 billion to develop new weapons. To effectively support clean energy RD&D, public investments should increase to at least $15 billion per year.[31] This would include fully funding key programs like the Advanced Research Projects Agency–Energy (ARPA-E), the Energy Innovation Hubs, the National Labs, and the Energy Frontier Research Centers.



Implement a Consistent Funding Stream for Clean Energy Innovation Programs
Innovation requires consistent support, rather than the boom-and-bust budgets innovation programs face today due to budget cuts and sequestration.[32] Previous historic technological breakthroughs have utilized long-term consistent funding, such as the development of shale natural gas supported by a surcharge on gas prices.[33] Providing the same level of support is crucial to the development of next-generation clean energy and a number of options exist, including raising revenue from increased royalty rates on oil and gas drilling to implementing a small carbon tax to fund innovation.[34]

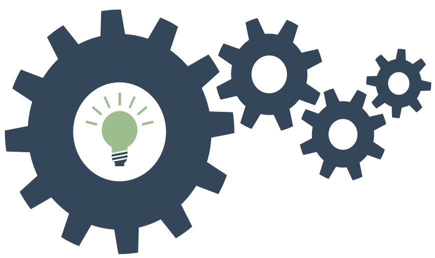
Reform Clean Energy Deployment Policies to Drive Innovation
Early support for deploying clean energy is important because fossil fuels fuels have received almost a century's worth of subsidies, regulation, and infrastructure, allowing for a significant advantage in energy markets around the world. And to date, clean energy has received early deployment subsidies—over two-thirds of public investments in clean energy have gone to tax incentives and grants for deployment. But these deployment incentives are more like blunt tools that continue to deploy along similar technology pathways, rather than support the deployment of better technologies. As a result, reforming clean energy deployment programs is essential to a well-tuned innovation ecosystem. This includes expanding the use of government procurement as an early customer of breakthrough clean energy technologies as well as changing tax incentives so that they temporarily reward next-generation technologies that are improving, rather than perpetually supporting the same technologies year after year.[35]

Reform and Strengthen the National Lab System
An energy innovation ecosystem is only as good as its underlying institutions. The National Lab system represents almost $15 billion per year in R&D investments for breakthrough work in leading disciplines and capabilities, including clean energy, not seen in the private sector or universities. But as it stands, the National Labs' mission, incentives, and management structure are ill-prepared, to rapidly connect lab research successes into the private sector. For a cohesive, non-partisan list of reform recommendations, see ITIF's *Turning the Page: Reimagining the National Lab System in the 21st Century Innovation Economy*.[36]



Reform and Strengthen the Nuclear Regulatory Commission

Nuclear energy represents a key zero-carbon energy source for global decarbonization. But because of its potential security and health risks, it is the most regulated energy technology in the market today. New nuclear reactors, both current generation and next-generation, must be licensed by the Nuclear Regulatory Commission (NRC), long considered the premier regulatory body in the world. But given the world's climate challenges and the need for cheap, better, unsubsidized zero-carbon energy, the NRC process is ill-equipped to drive innovation. The licensing process is costly, time consuming, and largely geared towards existing technologies. It is not managed, operated, or situated to quickly understand and fairly regulate new reactor designs, a monumental barrier to nuclear energy innovation.[37] The NRC must be reformed so that entrepreneurship and innovation are also supported along with its premier focus on public safety and health.



Shift International Climate Negotiation Focus from Carbon Caps to Innovation

According to the International Energy Agency (IEA), the world needs to globally invest $40 to $90 billion per year to stimulate the development of affordable clean energy technologies.[38] Yet, according to ITIF analysis, global clean energy RD&D investments total at most $16 billion in 2008.[39] To fill this gap, countries should be offered a choice: they can agree to carbon reduction targets, such as those being negotiated in Bonn and Warsaw this year in the lead-up to a 2015 deadline, or they can agree to meet gradually increasing government clean energy RD&D intensity targets. A clean energy RD&D intensity target of even 0.065 percent of GDP, for example, would boost global investments by $19 billion (to $35.5 billion globally, assuming 2008 data). Of course, higher targets can be set.

ENDNOTES

1. The U.S. Energy Information Administration predicts that fossil fuels will continue to supply almost 80 percent of the world's energy use through 2040. See: Energy Information Administration, "International Energy Outlook 2013," July 2013, http://www.eia.gov/forecasts/ieo/?src=home-b2.

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8. U.K Government Office for Science, "Climate Science: The World is Warming," http://www.bis.gov.uk/go-science/climatescience/world-is-warming.

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12. Recent global carbon dioxide concentration data can be found here: http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo_data. A good discussion on historic, pre-industrial carbon dioxide concentration data can be found at Tom Wigley, "The Pre-Industrial Carbon Dioxide Level," *Climatic Change*, 5(4), 315-320, December 1983.

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15. Val Giddings, Matthew Stepp, and Mark Eliot Caine, *Feeding the Planet in a Warming World* (Washington, DC: ITIF, April 2013), http://www.itif.org/publications/feeding-planet-warming-world.

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21. The properties of the Kaya Identity are detailed in: Roger Pielke Jr., *The Climate Fix: What Scientists and Politicians Won't Tell You About Global Warming*, (Basic Books: 2010). The Kaya Identity suggests that global GHG emissions are equal to global population multiplied by global GDP per capita, multiplied by global energy intensity, multiplied by global carbon intensity. According to Pielke, energy intensity is a measure of energy consumption per dollar in the economy (GDP), and carbon intensity measures the carbon content of total energy consumption. Multiplying energy intensity by carbon intensity gives a measure of the carbon intensity of the economy in metric tons of CO2 per dollar of GDP, which is used in this analysis. Data for the calculations is from the Energy Information Administration, *International Energy Outlook 2013*, Report Number DOE/EIA-0484, July 2013, http://www.eia.gov/forecasts/ieo/more_highlights.cfm. For more information on the statistics and analysis used in the report see: http://www.eia.gov/oiaf/aeo/tablebrowser/#release=IEO2013&subject=0-IEO2013&table=10-IEO2013&region=0-0&cases=Reference-d041117.

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GRAPHIC ATTRIBUTIONS:

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Icons obtained via The Noun Project:

Brennan Novak
Plinio Fernandes
Luis Prado
Olivier Guin
Benjamin Orlovski
Prerak Patel
Simon Child
Isabel Gueren
Jonathan Keating
Renee Ramsey-Passmore
NDSTR
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Iconathon
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Sergey Krivoy

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The Information Technology and Innovation Foundation (ITIF) is a Washington, D.C.-based think tank at the cutting edge of designing innovation strategies and technology policies to create economic opportunities and improve quality of life in the United States and around the world. Founded in 2006, ITIF is a 501(c)(3) nonprofit, non-partisan organization that documents the beneficial role technology plays in our lives and provides pragmatic ideas for improving technology-driven productivity, boosting competitiveness, and meeting today's global challenges through innovation.

FOR MORE INFORMATION, CONTACT ITIF BY PHONE AT 202.449.1351, BY EMAIL AT MAIL@ITIF.ORG, AND ONLINE AT WWW.ITIF.ORG. JOIN ITIF ON LINKEDIN OR FOLLOW ITIF ON TWITTER @ITIFDC AND ON FACEBOOK.COM/INNOVATIONPOLICY.