Comments of ITIF

Before the

House Committee on Energy and Commerce

Washington, D.C. 20515

In Response to the Climate Questionnaire

Regarding the Committee's Plan to Achieve a 100 percent Clean Economy by 2050

October 11, 2019

INFORMATION TECHNOLOGY AND INNOVATION FOUNDATION | 700 K STREET NW | SUITE 600 | WASHINGTON, DC 20001
ITIF.ORG | MAIL@ITIF.ORG | (202) 449-1351

INTRODUCTION AND SUMMARY

Thank you for the opportunity to provide input on key considerations for U.S. climate policy. The Information Technology and Innovation Foundation (ITIF) is a non-profit, non-partisan research and educational institute focusing on the intersection of technological innovation and public policy. ITIF's mission is to formulate and promote policy solutions that accelerate innovation and boost productivity to spur growth, opportunity, and progress.

1. WHAT ARE THE KEY POLICY, REGULATORY, AND MARKET CONSIDERATIONS THAT SHOULD INFORM THE DEVELOPMENT OF COMPREHENSIVE CLIMATE LEGISLATION?

We offer seven principles to underpin the development of comprehensive climate policy:

Principle 1: Climate change is a global challenge that requires global solutions. U.S. climate policy should leverage American strengths to drive global action.

The United States contributes only about 15 percent of global greenhouse gas emissions, a share that will continue to decline as developing countries like China and India raise their living standards and energy consumption. For this reason, eliminating U.S. emissions, by itself, would not solve the problem of climate change. Yet the United States has substantial leverage to reduce emissions elsewhere. The obvious first step in any plan is for the United States to set a good example by cutting its own emissions and to use its diplomatic influence to encourage other nations to achieve more ambitious goals within the nationally determined framework of the Paris climate accord. The United States should also lead other nations in meeting its Mission Innovation pledge to double investment in clean energy research, development, and demonstration (RD&D).[1] Most importantly, federal policy should mobilize America's technical and business communities to develop clean energy systems that are cheaper and better than dirty ones. This is the only way that most nations, especially developing nations, will make the switch to clean energy. The United States must sustain and extend its position as the clean energy innovation leader and drive progress globally if the worst consequences of climate change are to be avoided.

---

[1] Colin Cunliff and David M. Hart, "Global Energy Innovation Index: National Contributions to the Global Clean Energy Innovation System," (Information Technology and Innovation Foundation, 2019), http://www2.itif.org/2019-global-energy-innovation-index.pdf; Colin Cunliff, "Omission Innovation: The Missing Element in Most Countries' Response to Climate Change," (Information Technology and Innovation Foundation, 2018), https://itif.org/publications/2018/12/10/omission-innovation-missing-element-most-countries-response-climate-change; Colin Cunliff, "Omission Innovation 2.0: Diagnosing the Global Clean Energy Innovation System," (Information Technology and Innovation Foundation, 2019), https://itif.org/sites/default/files/2019-omission-innovation-2.pdf.

Principle 2: Comprehensive climate policy should cover all sources of emissions and all sectors of the economy.

The energy innovation agenda of the last 10 years has focused, with considerable success, on reducing the cost and expanding the use of wind and solar resources for electricity generation. It is time now to expand the agenda beyond this "low-hanging fruit." Reducing carbon emissions to zero will require a broader set of technologies that cover all sectors of the economy in order to provide energy that is as cheap and reliable as that from fossil fuels. The effort should extend to harder-to-decarbonize sectors such as air travel and shipping, cement and steel production, and firm electricity for which there are currently few carbon-free options. (These sectors, which are described below, now account for about a third of global emissions.) The United States should also lead an international effort to find low-cost ways to capture carbon directly from the air, a strategy which seems increasingly likely to be necessary, given the continued rise in global emissions.[2]

Principle 3: Today's technologies are not sufficient to serve as the infrastructure of a low-carbon energy transition. Energy innovation should be a central pillar of U.S. climate policy.

For most Americans, fossil fuels remain the cheapest source of energy. In the electric power sector, unabated natural gas remains the cheapest source of electricity in most U.S. counties, though wind and solar have made impressive gains.[3] Other sectors—including buildings, industry, transportation, and agriculture—are even harder to clean up, largely because of the absence of lower-cost clean alternatives that provide the same level of energy services as unabated fossil fuels. Continued innovation will be necessary to lower costs and improve performance of existing clean technologies, and to develop new clean energy options that address innovation challenges in the harder-to-decarbonize sectors. Today's technologies have the potential to bend the carbon emissions curve, but only better and cheaper technologies will create a real prospect for achieving a net-zero-emissions economy by 2050, as the IPCC's recent 1.5 degree report clearly shows would be in humanity's best interests.

Principle 4: Markets will not produce the needed level of innovation on their own. Government must invest and create conditions under which firms will innovate.[4]

Public investment and private investment play complementary roles in the commercialization of new energy technologies. The private sector is very good at improving mature technologies and developing nearly mature ones into marketable products. However, private energy innovation is largely incremental and usually focused

---

[2] Robert D. Atkinson, "Carbon removal: An opportunity for American innovation," *The Hill,* November 20, 2018, https://thehill.com/opinion/energy-environment/417706-carbon-removal-a-new-opportunity-for-american-innovation; Colin Cunliff, "It's Time to Start Pulling Carbon Out of the Atmosphere," (Information Technology and Innovation Foundation, 2018) https://itif.org/publications/2018/10/24/its-time-start-pulling-carbon-out-atmosphere.

[3] http://calculators.energy.utexas.edu/lcoe_map/. In 2018, natural gas combined cycle was the cheapest source of generation in 63 percent of U.S. counties; wind was the cheapest source of electricity in 27 percent; and utility-scale solar PV was cheapest in 10 percent of counties. However, these numbers include the tax credits for wind and solar.

[4] David M. Hart, "Rescuing the Low-Carbon Energy Transition from Magical Thinking," (Information Technology and Innovation Foundation, 2016), http://www2.itif.org/2016-rescuing-low-carbon-energy-transition.pdf.

on short-term payoffs. Key barriers to greater energy innovation include the high capital-intensity, high risk, and long payback periods of many of the most important investments. The federal government is uniquely suited to address these barriers, making the kinds of investments the private sector is simply unwilling to fund. Moreover, federal investment frequently serves as a catalyst for industry, attracting and "crowding-in" private investment, rather than crowding it out.

Principle 5: Complement "supply-push" policies with "demand-pull" policies.

The success of energy innovation depends ultimately on meeting the test of markets. Subsidies of indefinite duration are not acceptable. The creation of temporary protected market niches, however, may be vital in bringing costs down while production ramps up, and in providing working capital to early-stage firms. "Demand-pull" policies such as government procurement and time-limited tax incentives have been shown to be valuable complements to the "supply-push" provided by federal research, development and demonstration (RD&D) funding for many transformative innovations in the past.

Principle 6: Invest in innovation at a scale that is commensurate with the climate challenge.

Current levels of funding for RD&D in the public and private sectors do not match the urgency and scale of investment needed to put the United States and the world on a path to net-zero carbon emissions, and there are signs that the clean energy transition is beginning to stall, just when the world needs it to accelerate.[5] The U.S. Department of Energy (DOE) currently invests about $7.3 billion annually in energy RD&D. This investment is well below historical levels—Congress invested nearly $10 billion (in 2017 dollars) in DOE's energy RD&D programs when the department was created in 1978—and far from the United State's Mission Innovation (MI) pledge to double RD&D to over $12 billion.[6] Other nations have similarly fallen short of their MI commitments. Total MI investment in clean energy RD&D stands at $19.7 billion in 2018, well shy of the $30 billion nations committed to invest by 2020 as part of Mission Innovation.[7]

---

[5] Colin Cunliff, "Omission Innovation 2.0: Diagnosing the Global Clean Energy Innovation System," (Information Technology and Innovation Foundation, 2019), https://itif.org/publications/2019/09/23/omission-innovation-20-diagnosing-global-clean-energy-innovation-system.

[6] Colin Cunliff, "FY 2020 Energy Innovation Funding: Congress Should Push the Pedal to the Metal," (Information Technology and Innovation Foundation, 2019), https://www.itif.org/energy-budget.

[7] Colin Cunliff, "Omission Innovation 2.0: Diagnosing the Global Clean Energy Innovation System," (Information Technology and Innovation Foundation, 2019), https://itif.org/sites/default/files/2019-omission-innovation-2.pdf.

Principle 7: Congress should adopt a portfolio approach to climate policy in order to manage risks and uncertainty.

A prudent strategy calls for hedging one's bets, as innovation is intrinsically uncertain. No one knows precisely what the energy landscape will look like in 2050; when the learning curves for the current generation of wind and solar technologies will reach their limits; or which nascent clean energy option will emerge and scale-up to address harder-to-decarbonize sectors. The world needs to build a robust portfolio of options not only to address the diversity of challenges across the global energy system, but also so that we are ready to cope with the inevitable surprises and failures that come with innovation. This requires a technology-inclusive approach that doesn't exclude any zero-carbon options.

2. PLEASE DESCRIBE ANY INNOVATIVE CONCEPTS FOR CLIMATE POLICY DESIGN, INCLUDING BOTH SECTOR-SPECIFIC AND ECONOMYWIDE MEASURES, THAT YOU BELIEVE THE COMMITTEE SHOULD CONSIDER.

In our response to this question, we focus on ensuring that climate policy, whether economy-wide or sectoral and regardless of the particular policy tool being employed, continually supports, encourages, and induces innovation.

Recommendation #1: Use a portion of the revenue generated by any economywide climate policy (such as a clean energy standard or carbon price) to support clean energy innovation.[8]

Economywide climate policies typically focus action on the least-cost abatement options. A carbon price, for instance, seeks to incorporate some or all of the negative externalities of unabated fossil fuel consumption into market behavior, nudging consumers to adopt technologies that are already nearly competitive. The strategy of cost minimization has a weakness: it does little to pull forth early-stage, disruptive technology that has the potential to become competitive in the market but is not yet close to that point.[9] Federal RD&D investment and other "technology-push" policies complement the "market-pull" provided by economywide climate policy. The *Quadrennial Energy Review* found that coupling increased RD&D with a carbon price would not only enable greater emissions reductions, it would also lower energy costs and improve energy security. Setting aside a portion of the revenue generated by the latter could provide a huge boost to the former.[10] For instance,

---

[8] Matthew Stepp and Robert D. Atkinson, "An Innovation Carbon Price: Spurring Clean Energy Innovation while Advancing U.S. Competitiveness," (Information Technology and Innovation Foundation, 2011), https://www.itif.org/files/2011-innovation-carbon-price.pdf.

[9] Matt Hourihan and Robert D. Atkinson, "Inducing Innovation: What a Carbon Price Can and Can't Do," (Information Technology and Innovation Foundation, 2011), https://www.itif.org/files/2011-inducing-innovation.pdf;

[10] This is not a new idea, and the two carbon-pricing policies already in existence in the United States—California's cap-and-trade program, and the Regional Greenhouse Gas Initiative—do this to some extent. A portion of the revenue from California's program funds the Dairy Digester Research and Development Program which aims to reduce methane emissions and generate biogas from the dairy sector. Similarly, RGGI states have invested an average of 3 percent of the revenue from RGGI on clean technology research and development.

a carbon fee of just $2.85/tCO_2$—equivalent to a fee of 2.5 cents per gallon of gasoline—would raise $15 billion annually, more than twice what the federal government currently invests in clean energy RD&D.[11]

Recommendation #2: Target clean energy in any infrastructure bill and set aside a portion of infrastructure funding to support innovative projects.

Infrastructure investment for both mitigation and adaptation is a necessary and significant component of a comprehensive, economywide approach to climate. The energy infrastructure of the United States is old and creaky, earning a D+ from the American Society of Civil Engineers.[12] While many infrastructure investments are shovel-ready, any federal infrastructure program should not merely replace dams, transmission lines, and the like but explore the potential to add new functionalities and make step-changes in performance.

Recommendation #3: Tighten energy efficiency and carbon-control regulations in a predictable, innovation-inducing manner.[13]

Federal regulations on appliances, vehicles, power plants, and industrial facilities (as well as state and local building codes supported by federal technical assistance) have prevented a substantial amount of greenhouse gas emissions, and will prevent much more in the future. In most cases, they have cost much less than anticipated and had little impact on the quality of energy services. However, the regulatory process has also failed on some occasions. Poorly-designed policies can "lock-in" subpar technologies and deter investment in further innovation. At its best, the regulatory process engages technically savvy agency staff with industrial experts in order to set aggressive but feasible performance standards on a time frame that allows industry to plan ahead to meet them. Long-term targets provide a focus for industrial investments in innovation as well as opportunities to make adjustments if the innovation process does not yield hoped-for results in the expected time frame. Predictable, steady, collaborative ratcheting-down of standards may also avert litigation from those who have participated in the standard-setting process.

Recommendation #4. Encourage business-model and regulatory innovation in conjunction with technological innovation.

Technological innovation has a symbiotic relationship with business-model and regulatory innovation, particularly in complex systems such as electricity and transportation. New technologies open up opportunities for new business models, which regulators may or may not encourage, which in turn may or may not feed further technological innovation. Distributed energy resources and the application of information technology to the electricity and transportation systems offer opportunities to trigger a virtuous

---

11 ITIF estimates that the U.S. Department of Energy (DOE) invested about $7.3 billion in energy RD&D in FY 2019, which includes $4.1 billion in the applied energy programs (EERE, FE, NE, OE, and CESER), $2.8 billion in basic energy research within the Office of Science, and $366 million in ARPA-E. Colin Cunliff, "FY 2020 Energy Innovation Funding: Congress Should Push the Pedal to the Metal" (Information Technology and Innovation Foundation, April 2019), http://itif.org/energy-budget.

12 American Society of Civil Engineers, "2017 Infrastructure Report Card: Energy," https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Energy-Final.pdf.

13 David M. Hart, "When Does Environmental Regulation Stimulate Technological Innovation?" (Information Technology and Innovation Foundation, 2018), http://www2.itif.org/2018-environmental-regulation-innovation.pdf.

cycle of this sort with large-scale economic and environmental benefits. But the regulatory system in these sectors is a complex patchwork of federal, state, and local entities. Some of these entities are extraordinarily risk averse, while others are captured by incumbent providers that would be harmed by innovation. Federal agencies should exert leverage on the system to encourage innovation through their rulemaking powers, and they should also use their funding authority to support pilot programs and regulatory experiments that establish the viability of innovative approaches.

Recommendation #5: Ensure that tax incentives reward innovation and do not only subsidize adoption of established technologies.

In the absence of an economywide climate policy, like a carbon price or clean energy standard, tax incentives that promote the adoption of established low-carbon technologies will yield emissions reduction benefits. However, providing incentives for older technologies impedes the development of next-generation solutions. The former are almost always less expensive than the latter, yet the policy gives them the same discount to compete for virtually the same customers. Ideally, tax incentives create bridges across the vaunted "valley of death," which often prevents innovations from reaching their full potential. The bridge straddles the public-oriented demonstration phase of clean energy innovation, in which the viability of the innovation to reduce emissions at a reasonable cost is shown, and the fully-private mass adoption phase, when that potential is realized. Incentives should be focused on technologies with the greatest potential to move rapidly down the experience curve. If phasing out incentives for incumbent technologies entirely is infeasible, policymakers should target innovative technologies with a more generous tier of incentives.

Recommendation #6: Address the technology commercialization "gap" and enhance policies that translate the results of research and development into commercial products.

The investments government and businesses make in basic and applied research and development (R&D) plant the seeds for the energy technologies and industries of tomorrow. But the increased complexity of technological innovation means that it is no longer enough to simply fund scientific and engineering research and hope it gets translated into commercial results. The U.S. government should improve the processes by which federally funded energy RD&D leads to U.S. innovation and jobs and should expand technology transfer and commercialization-related programs and investments.[14]

---

[14] Stephen J. Ezell and Robert D. Atkinson, "ITIF Comments Responding to Administration Request for Information Regarding Federal Technology Transfer Authorities and Processes," submitted to the National Institute of Standards and Technology, (ITIF, 2018), http://www2.itif.org/2018-nist-rfi-tech-transfer.pdf.

The federal technology transfer reform agenda includes adapting the Small Business Innovation Research (SBIR) program to focus on growth and commercialization; leveraging Department of Defense (DOD) investments in energy innovation; and strengthening private-sector partnerships with the DOE National Labs.[15]

Recommendation #7: Balance diplomatic efforts to secure nationally-determined reductions in emissions with efforts to spur international cooperation to accelerate innovation.

The Paris climate accord created a process by which nations commit to reduce their emissions. Over time, these commitments are meant to ratchet upward, and this increasing ambition should ultimately rise to the level that the climate challenge requires. While this diplomatic strategy led to a global agreement, its success depends entirely on the availability of mitigation options that are affordable and effective in a wide variety of applications. Accelerated clean energy innovation is essential for the creation and scale-up of these options. The United States, as the world's science and technology leader, should place great weight in its climate diplomacy on spurring energy innovation globally. The relevant research communities, industries, and financial institutions span nearly every border, but national governments remain the most important contributors to energy innovation. The global effort is currently falling far short of what is required, with public RD&D investment rising very slowly and energy patents falling.

3. IF YOU WORK IN, ADVISE, OR ARE FAMILIAR WITH SECTORS THAT ARE PARTICULARLY CHALLENGING TO DECARBONIZE, HAVE YOU IDENTIFIED ANY EFFECTIVE (AND SCALABLE) SOLUTIONS THAT SHOULD BE INCLUDED IN COMPREHENSIVE CLIMATE LEGISLATION?

ITIF analysis has identified three sources of "difficult-to-eliminate" emissions that will require fundamental breakthroughs and greater attention from policymakers as they seek to develop low-carbon solutions: firm, dispatchable electricity; hard-to-electrify transport; and industrial-sector emissions.[16]

Firm, dispatchable electricity.

Nearly all net-zero scenarios identify the need for "firm" low-carbon electricity to balance both variability in electricity demand and variable output from wind and solar. Firm electricity refers to electricity that can be generated and dispatched as need needed in all seasons and over periods of weeks or longer. Variability on these timescales has traditionally been balanced by flexible generation from natural gas power plants. However, full decarbonization of the electricity system will require low-carbon firm, dispatchable electricity

---

15 Robert Rozansky, "Becoming America's Seed Fund: Why NSF's SBIR Program Should Be a Model for the Rest of Government," (Information Technology and Innovation Foundation, 2019), https://itif.org/sites/default/files/2019-nsf-sbir-program.pdf; Dorothy Robyn and Jeffrey Marqusee, "The Clean Energy Dividend: Military Investment in Energy Technology and What It Means for Civilian Energy Innovation," (Information Technology and Innovation Foundation, 2019), http://www2.itif.org/2019-clean-energy-dividend.pdf; Information Technology and Innovation Foundation, "New Ideas for Strengthening Partnerships at DOE National Labs," (2018) https://itif.org/events/2018/06/27/new-ideas-strengthening-partnerships-doe-national-labs.

16 Colin Cunliff, "An Innovation Agenda for Deep Decarbonization: Bridging Gaps in the Federal Energy RD&D Portfolio," (Information Technology and Innovation Foundation, 2018), http://www2.itif.org/2018-innovation-agenda-decarbonization.pdf.

that can manage variability across all timescales. Options include long-duration energy storage that can storage large quantities of electricity on weekly and seasonal timescales; hydrogen and other carbon-neutral fuels that can function as one particular type of long-duration storage; small modular nuclear reactors that are flexibly operated; and fossil fuel power plants equipped with carbon capture and storage technologies.

Hard-to-electrify transport: aviation, shipping, and long-distance road transport.

In the transportation sector, low-carbon electricity is emerging as a promising alternative for petroleum fuels for light-duty cars and trucks. However, air travel, shipping, and long-haul trucking will likely continue to rely on liquid fuels because of their high energy density. Eliminating emissions from air travel, shipping, and long-haul trucking will require carbon-neutral fuels. Hydrogen produced from water electrolysis (using carbon-free electricity), synthetic hydrocarbon fuels made from ambient carbon dioxide, and carbon-neutral ammonia are all potential solutions.

Industrial emissions from heat and industrial processes.

The industrial sector is especially challenging to decarbonize due to two sets of emission sources that are difficult, if not impossible, to eliminate using existing technologies. First, the high-temperature heat used in many industrial processes is primarily generated by combusting fossil fuels. Electrification of heat can be used for lower-temperature applications, such as washing and sterilizing, but electrification of high-temperature heat poses cost and technical barriers, and may require significant changes to industrial processes. Second, "process" emissions result directly from chemical transformations and cannot be eliminated by switching to low-carbon energy sources. Carbon capture and storage may be the only option for mitigating process emissions. Hydrogen or other carbon-neutral fuel could be combusted to generate high-temperature heat. Nuclear energy can provide heat for some industrial processes. And concentrating solar power (CSP) may be suitable from some applications.

Technology missions for harder-to-decarbonize sectors.

Accelerating energy innovation in these sectors requires a suite of policies acting together across the innovation spectrum. For technologies that are far from commercialization, public investment in basic and applied research and technology development is necessary to improve the performance and drive down the cost of emerging technologies to the point that entrepreneurs and corporate R&D units jump in. As technologies mature, successful demonstration at commercial scale may be necessary to establish cost, reliability, and performance characteristics and provide confidence to more risk-averse investors and the public that the technology works as intended.

Additional tools such as loan guarantees, green banks, time-limited tax incentives, and clean energy standards tend to incentivize greater private-sector investment to commercialize technologies, which in turn should pull them further down the cost curve. Tax-advantaged structures such as master-limited partnerships and private activity bonds can give innovative companies access to low-cost capital. The Export-Import Bank can help expand markets for domestic technologies overseas.

Thank you again for this opportunity to provide input as the Committee works to develop comprehensive climate policy.

Colin Cunliff
Senior Policy Analyst
ccunliff@itif.org

David M. Hart
Senior Fellow
dhart@itif.org