



Low-carbon Innovation

A Uniquely American Strategy for Industrial Renewal

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Introduction and summary

Our nation's innovation and competitive drive in the 20th century powered the U.S. economy to global leadership, helped win two World Wars and one Cold War, created unprecedented and broad-based economic prosperity, and established the technology that enabled the conquest of the moon and today's Information Age. Today, this same engine of innovation is in serious jeopardy as we look across the competitive landscape of the 21st century.

Though the U.S. economy is slowly recovering from the Great Recession of 2007-2009, more than 23 million Americans remain unemployed or underemployed.¹ Creating new job opportunities remains a top-tier economic challenge, particularly in manufacturing, where job skills are higher, the pay is better, and export opportunities are the greatest. The United States remains the world's largest manufacturing nation, a position it has held for more than a century, but China is poised to claim this global leadership by 2016, and by some estimates, China has already surpassed the United States.²

For decades, the manufacturing sector supplied millions of Americans with stable, well-paying jobs and sustained our country's ability to innovate and stay ahead of the curve in advanced technology. Yet in recent years, U.S. companies found many reasons to shift manufacturing overseas, among them lower labor costs and environmental standards. But increasingly they are also drawn to foreign government subsidies to attract investment, and the need to be closer to rapidly growing foreign markets. This not only costs jobs but also, as the *Harvard Business Review* points out, it costs our economy's ability to make high-tech products and invent new ones.³ Offshoring manufacturing is undermining America's global economic position and competitive edge.

Compounding this threat to American competitiveness in coming years are the increasing risks that U.S. businesses will face from global warming. The consequences of global climate change will deliver real, and potentially very large, economic costs. For instance, the uncertainty around how climate change will affect

precipitation patterns, which is just one piece of the overall climate puzzle, could cost the U.S. economy as much as \$2 trillion and up to 13 million jobs over the next 40 years, according to a recent study conducted by Sandia National Laboratories.⁴

America also suffers from a confused planning environment for infrastructure and economic decision making, which makes it difficult to move forward on any comprehensive plan to bolster sustainable economic growth. Congressional inaction on climate legislation and policies to deploy clean and efficient energy technologies here at home are creating deep uncertainties for business planning.⁵

This partisan standoff inhibits investment in U.S. jobs and industries in the clean-technology arena and across our industrial landscape as companies wait to discover whether the federal government will get serious about clean energy policy. Our competitors in other nations, already retooling their industries and infrastructure for a clean energy future, do not face such uncertainty. Without clear long-term climate and clean energy policies, and a supporting low-carbon economic growth strategy, capital investment in the United States will continue to lag, new hiring and business expansion will remain stalled, and U.S. global market share will erode.

Setting priorities: Jobs, innovation, and economic security

As President Barack Obama put it in his 2011 State of the Union address, “this is our generation’s Sputnik moment.” Faced with high unemployment, increasing global competition, and mounting climate-related risks, the United States has an immediate opportunity to forge progressive economic growth strategies that turn the threats posed by climate change and our rivals’ increased manufacturing and innovation prowess into opportunities.

Decades ago the challenge of the space race launched an earlier generation of public-private partnerships, advanced research and development, and increased domestic manufacturing. Likewise, today, well-crafted policies that reinvest in American jobs in response to the rising threat of climate change can help restore our industrial leadership. These policies should take shape through a cohesive set of federal, state, and local low-carbon economic growth strategies. A strong low-carbon economic growth strategy should focus on developing, producing, and commercializing low-carbon technologies in order to:

- Accelerate near-term job creation and economic growth
- Promote innovation-led economic competitiveness and export expansion
- Increase energy and economic security while reducing climate vulnerability

Success at delivering on these three clear national priorities depends on developing domestic markets for low-carbon products and services, with domestic demand strong enough to keep U.S. clean energy manufacturers at home. It is clear that industries and innovation develop in countries and regions with the strongest markets and demand. General Electric Company Chairman and CEO Jeff Immelt summed it up best when he observed that countries with policies to create strong demand for renewable energy products will pull companies into their borders because “innovation and supply chain strength develop where the demand is the greatest.”⁶

Indeed, U.S. company First Solar Inc., a pioneer of building solar power plants in the States, recently signed a deal to build the world’s largest solar plant in China.⁷ As First Solar CEO Mike Ahearn said, “this major commitment to solar power is a direct result of the progressive energy policies being adopted in China to create a sustainable, long-term market for solar and a low carbon future for China.”⁸ The project will be financed by CLEAN contracts, or feed-in tariffs, that will guarantee pricing and long-term demand for electricity produced. Such long-term and high-volume demand for solar does not yet exist in the United States. Beyond solar, the U.S. clean-technologies market is similarly not yet robust enough to keep many of the most innovative clean-technology companies at home.

In the face of confused policy and unclear signals on sustained domestic market demand for clean energy technology, America is beginning to fall behind our competitors. As a result, we are now importing key technologies and products from other countries—even some that were invented here. The Economic Policy Institute finds that our trade deficit in clean energy products with China alone now totals more than \$1 billion a year.⁹ We import 10 clean energy technology products from China for every one product we export to China, a deficit that cost at least 8,000 jobs in the United States in 2010 alone.

Low-carbon economic growth strategies that focus on building domestic markets by encouraging American consumer demand could reverse this trend, bringing clean-technology manufacturing back to our nation to balance the sectoral trade deficit with China, bring back jobs, and create new ones as well—in the end bolstering our national economic competitiveness.

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Given the broadly shared concern over economic recovery in the United States, this is an ideal moment to implement policies and programs that match the uniquely American economic and innovative strengths of our nation. Strategies that clearly identify opportunities for low-carbon economic expansion nationally, regionally, and locally will build domestic markets, reduce risk for investors, and increase competitive positioning through innovation.

What's more, the economic fundamentals supporting the expansion of low-carbon industries in our country are sufficiently strong to motivate significant actions within the current American political context. Supporting these industries will improve the efficiency, resilience, and diversity of the U.S. economy, even as climate policy debates proceed at their own pace.

Embracing a uniquely American economic growth strategy for clean energy-driven industrial renewal

America is unique among industrialized nations for our disdain for the term “industrial policy.” For many Americans, the very term conjures up an image of managed and centrally planned economies that cuts against the grain of our political and economic culture. In fact, the term is mostly used in other countries as shorthand for a comprehensive competitiveness and jobs strategy rather than as an indication of central planning or a desire to “pick winners and losers.”

Whatever the case, American political traditions generally focus on a more bottom-up economic development, which emphasizes entrepreneurship, individual enterprise, and the role of markets in shaping economic growth. Each of these factors is in fact critical in America's economic success story. But so is the role of government in fostering our culture of innovation and entrepreneurship. The fact is that past waves of American innovation did not emerge full-blown, independent of public-sector leadership.

Indeed, many of this country's greatest economic achievements have rested on significant public leadership in investment, strategic planning, and infrastructure capable of supporting rapid growth. Take, for example, technologies as diverse as solar panels, fuel cells, memory foam, microwave ovens, and the crucial imaging equipment used today in digital cameras and cell phones. Each of these technologies was developed for the space program before being commercialized by the private sector to create new industries and jobs.¹⁰

Where we stand in the world

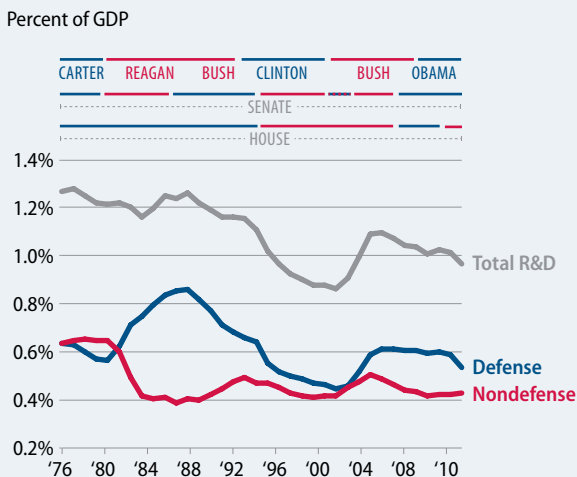
The United States boasts an unrivaled innovation and competitiveness infrastructure, the legacy of unparalleled public and private investments in the 19th and 20th centuries, but unfortunately in recent decades U.S. public commitment to research and development, infrastructure, and business innovation has lagged.

Since the 1960s our federal rate of investment in R&D as a percentage of gross domestic product has declined from nearly 1.3 percent to 0.9 percent.¹³ The United States is falling quickly behind countries such as South Korea and China, which are rapidly increasing their total R&D spending relative to the size of their gross domestic product, or overall economy. Declining investments in the United States have also led to crumbling physical infrastructure, putting us at a further disadvantage relative to other countries.

U.S. Energy Secretary Steven Chu recently pointed out that while China invests in high-voltage electric transmission systems to transfer renewable energy 1,200 miles to cities with energy losses below 7 percent, the aging American grid would lose about 80 percent of electricity over the same distance.¹⁴ Likewise, while countries such as South Korea and Finland top the charts on their education systems, American students have fallen to 25th place among the industrialized democratic members of the Organisation for Economic Co-operation and Development in terms of mathematics ability.¹⁵

U.S. government R&D spending on a sharp decline

Trends in federal R&D budget authorities as percentage of U.S. GDP, FY1976–2011



Source: OECD, Main Science and Technology Indicators (2009/1). See appendix tables 4-27 and 4-28. <http://www.nsf.gov/statistics/seind10/c4/c4s5.htm>

Most telling, the American Civil Society of Engineers gives American infrastructure almost failing marks: “D+” on energy, “D-” on roads, “C” on bridges, and “D-” on drinking water, with an overall grade point average of “D.”¹⁶ America’s underfunded infrastructure—from undereducated workers to the very roads on which companies transport goods—is eroding the competitiveness of U.S. industries, costing jobs and economic leadership.

Unlike the United States, China is actively pursuing an aggressive industrial strategy with a focus on low-carbon industries, infrastructure, and innovation. While China’s transition from an agrarian to an industrial economy presents different challenges and opportunities than does the American task of industrial renewal, its commitment to developing low-carbon industries and the infrastructure that supports them should not be overlooked.

Though China’s famous communist-era five-year plans often bore little resemblance to reality in decades past, today they are increasingly becoming blueprints for strategic, market-oriented, innovation-led economic growth.¹⁷ China’s most recent 12th five-year plan highlights energy conservation, new energy, and new-energy-fueled vehicles as three of the most important sectors for development, making clear that clean energy is at the center of China’s current agenda for both innovation and competitiveness.¹⁸ This five-year plan makes strong commitments to renewable energy and energy efficiency, as well as to the smart energy infrastructure that will bring this cleaner energy to market.

China today is demonstrating how a long-term industrial strategy can increase the certainty and predictability of market demand in order to jumpstart growth in strategic industries, and investors are paying attention. This global mobilization of capital underscores why our nation needs to recommit quickly to our future economic competitiveness. (see main text)

Modern medicine, too, would not exist as the world knows it without government support. Whether it was mastering the particle physics of magnetic resonance imaging techniques, funding the first steps that led to the creation of the cardiac pacemaker, or discovering the biological basis of diabetes, these life-saving technologies were built on the foundation of our public-private innovation infrastructure.¹¹ The same story holds true for the physical infrastructure of our ports and railroads, rural electrification, communications, and highways, as well as to the growth of intellectual capital and human capital through workforce training, intellectual property laws, and the world-class research institutions that drive corporate research.

In proposing a low-carbon economic growth strategy, we are fully aware that clean energy deployment in the United States faces numerous market barriers that may not be an issue in other countries.

These public investments, and the policies and programs supporting them, have helped create and strengthen the “building blocks of innovation,” from education and workforce training to research and development to manufacturing to infrastructure, that are the foundations of our world-class economy.¹² In this report we argue that these kinds of strategic planning and investment tools can be highly effective if they are applied with vigor toward the goal of creating an innovative clean energy economy. Our proposals are designed to build up these uniquely American attributes of economic growth to help our economy become more competitive within a global marketplace that includes countries that have already adopted comprehensive, far-reaching low-carbon growth strategies. (see box)

In proposing a low-carbon economic growth strategy, we are fully aware that clean energy deployment in the United States faces numerous market barriers that may not be an issue in other countries. In particular, electricity in this country is regulated within a patchwork of balkanized regional markets, which block the development of coherent national energy plans and slow deployment of new technology, placing even greater hurdles for clean energy than conventional infrastructure.¹⁹

Energy policy and the mechanisms for project approval and financing in the United States are extremely fragmented across federal agencies such as the Federal Energy Regulatory Authority, state entities including public utility commissions, multistate regional planning agencies, and local jurisdictions. This creates significant barriers to the growth of U.S. clean energy markets and hurts new industries as they try to scale production.

Indeed, the presence of policies that stimulate predictable market demand is one of the greatest drivers of clean energy investments globally. Yet as the United States seeks to establish market share in emerging clean-tech industries, the absence of a coherent national plan has in itself become a barrier to growth. For our domestic

clean energy sector to grow, the United States must embrace national policies and programs that account for the quirks and intricacies of our particular structure of state and regional utility regulation. Without such strategies, renewed investment in manufacturing through a focus on clean technology faces major hurdles while our existing carbon-intensive economy becomes less and less competitive.

Even in a policy environment shaped by differentiated state policies and diverging political interests, it should nonetheless be possible to develop a common framework for clean-tech expansion, grounded within deep federalist traditions of economic development, to help speed the growth of a truly national market for advanced low-carbon energy technologies. This paper explores how to develop just such distinctly American economic growth strategies to drive new investment in domestic low-carbon industries and improve our global competitiveness from the bottom up. We delve into the details in the main part of our report, but here we summarize where we are, where we need to go, and how to get there.

Building on our strengths in innovation and entrepreneurship

The U.S. economy is an “innovation-driven” economy, according to the World Economic Forum.²⁰ We have moved beyond an economy where growth and opportunity are driven by basic factor inputs such as land, labor, and natural resources. Instead, since the industrial revolution, the American economy has run on the continual advancement of ever more sophisticated technologies, business practices, and institutional structures. As President Obama explains it, “in America, innovation doesn’t just change our lives. It is how we make our living.” He’s right, of course. The Nobel Prize-winning economist Robert Solow estimates that technological innovation could have been responsible for as much as 80 percent or more of economic growth during the 20th century.²¹

With this firmly in mind, any American strategies for competitiveness and growth must be innovation-driven.²² With our high standards of living and laws that enforce fair wages, the United States cannot compete on low wages alone—nor should we want to. Instead, we should focus on America’s strengths as an innovative high-tech leader. The United States became a global economic leader by building a diverse economy driven by a continuous innovation business model—one that values inventing, manufacturing, and continually reengineering value-added products and sophisticated technologies. Innovation is our area of expertise and it should be at the center of our low-carbon industrial strategy.

With increasing climate pressures, clean technology today is at the leading edge of innovation. Massive waves of new global investment have begun to flow toward remaking the world's energy systems and increasing the efficiency of energy use across the real economy by engaging advanced technology and skilled labor to reduce demand for material inputs. Even in 2009, deep within the global recession, world investment in clean technology totaled \$162 billion, according to the Pew Charitable Trust.²³

Most of these investments went toward wind and solar technologies that American companies have developed and perfected. This is exactly the context where U.S. companies are best poised to compete with global industries. For the United States to remain competitive in this rapidly changing economic climate, however, policies that foster domestic innovation in low-carbon industries will be essential. Clean technologies offer an ideal business challenge for U.S. industry to excel—one that requires creativity, experience, and innovative entrepreneurship—qualities that the United States has demonstrated for centuries.

Key to taking the lead in clean technology will be advancing a uniquely American economic growth strategy that builds on our existing regional ecosystem of economic development policies. Such a strategy should align policies that exist across different branches of government and utilize smart incentives to engage private capital markets in deploying essential low-carbon technologies and reinvigorating investment in cutting-edge infrastructure.

Building innovation networks that are greater than the sum of their parts

Organizing and aligning the many elements of low-carbon industrial strategies—innovation policy, economic and workforce development policy, environmental goals, and a range of other policies at multiple levels of governance and affecting many if not all economic sectors—into a coherent national framework is indeed challenging. There are many possible ways to tackle this effort. Our approach in this paper seeks to simplify the problem by answering two basic questions:

- What types of participants are needed for low-carbon industrial growth and transformation?

- How can policy engage these market participants to incentivize better outcomes in achieving our national goals of creating jobs, promoting long-term economic competitiveness, and reducing our economic vulnerability to climate change and foreign energy dependence?

In offering our answers to these questions, we've identified five types of market actors whose participation is essential for low-carbon industrial renewal:

- Policymakers and regulators
- Researchers
- Manufacturers
- Investors
- Consumers

All five of these must work together for innovation to succeed because they are all interdependent. No one of these players can innovate without the rest. The popular conception of clean energy is that we simply need more researchers studying it. But without manufacturers competing to find, market, and produce the best technologies at scale, that research will remain purely academic. Without investors and functioning capital markets to finance those manufacturers' factories, economies of scale cannot be reached and technologies cannot make it to market. And perhaps more importantly, without consumers of clean energy goods such as homeowners, commercial building owners, construction companies, and utility companies, there is no incentive for the manufacturers or the investors to produce, market, and sell new technology.

As President Obama recently said:

When you get a group of people together, and industries together, and institutions like universities together around particular industries, then the synergies that develop from all those different facets coming together can make the whole greater than the sum of its parts.²⁴

The bottom line is that when these five groups work together by exchanging information, money, and risk, the network they form is more innovative than the sum of its parts. Together they can accomplish what none of them can do alone. As policymakers look for ways to catalyze clean energy innovation and industrial transformation, they should continue to consider how their policies will affect each type of player and choose policies that encourage the interaction—through

business deals, contracts, memoranda of understanding, research agreements, and even through the simple relationship between buyer and seller of a piece of sophisticated equipment, with all the feedback, warranties, interaction, and learning that involves.

With this understanding, we've organized our discussion of specific policies through the lens of how to engage each of these constituencies and encourage the formation of an informal national clean energy innovation network. We lay out here principles for how policy can align the interests of each of these industrial and economic actors around shared efforts to drive low-carbon innovation in America's economy.

Coordinating policymakers and regulators

Policymakers, regulators, and program officers in federal and state agencies play an important role in every stage of innovation and industrial development, whether by siting new transmission infrastructure, permitting a new wind farm, providing programmatic support to help finance an advanced manufacturing facility, or coordinating public R&D research funds. Policymakers, regulators, and government agencies can directly facilitate the growth of low-carbon markets and industries by aligning all efforts to build strong market demand, by influencing government procurement practices, and by offering clear frameworks for business planning within their rulemaking and legislating.

Empowering clean energy researchers

From advanced electric vehicle batteries to super-cheap solar panels to the manufacturing processes that produce them, research conducted in government, university, and corporate labs is critical to advancing innovation and the growth of low-carbon industries. Public policies provide important support for scientists and engineers as they work to create low-carbon solutions to industrial challenges, and ensure their discoveries can move quickly into the market.

Mobilizing clean energy manufacturers

Manufacturers who develop the supply chains, production processes, and marketing strategies to scale up the supply of American clean energy prod-

ucts, equipment, and technology play an important role in innovation and form the basis of industrial growth. Public policies play a critical role in helping America's existing industrial base navigate the transition to a clean energy economy, supporting worker training and retooling manufacturing for low-carbon technologies.

Incentivizing clean energy investors

The task of innovating and scaling up a new technological foundation for U.S. industry based on clean energy requires harnessing flows of private capital. Clean energy and energy efficiency standards can send powerful signals to investors on the permanence of clean energy markets, while targeted financing assistance programs can help mitigate risks and unlock private capital for clean energy. These policies can leverage private capital more effectively within stalled capital markets and can improve incentives for private investment in clean energy research, commercialization, and deployment.

Engaging clean energy consumers

The consumers of clean energy products and technology provide the critical domestic market demand that makes industrial growth and innovation possible. Without consumers to purchase and use zero-emission vehicles, building owners and construction firms to use energy-efficient building materials, or utilities to invest in and operate renewable-energy-generating technologies, there is no revenue stream for the manufacturers of those goods, no reason for investors to provide capital, and no market application for clean energy research. Consumer-driven demand—from families to businesses to utility companies—is what makes clean energy innovation and industrial transformation possible.

Public policies can increase demand for clean energy goods and services by establishing meaningful incentives for utilities, building owners, and consumers to invest in clean energy technologies instead of fossil-fuel energy generation. Indeed, policy is essential to dramatically increase the predictability, transparency, and long-term certainty of clean energy markets to reach economies of scale and bring down cost.

Aligning the interests of policymakers, researchers, manufacturers, investors, and consumers

Low-carbon industrial growth strategies in the United States must rely in equal measure on existing federal and state authorities alongside strategically supported bottom-up private-sector innovation to respond to emerging market needs.

Government support is necessary to correct current market failures and already existing incentives that discourage low-carbon development. For instance, the market fails to account for the cost of fossil-fuel pollution and national security threats associated with reliance on high-carbon imported oil, not to mention human health problems and damage to land- and water-based ecosystems. The National Resources Defense Council estimates that the externalized costs associated with fossil-fuel-induced climate change will total \$271 billion annually by 2025 and \$1.87 trillion annually by 2100, without even taking into account the additional environmental and human health costs.²⁵

These externalized, uncounted costs make fossil fuels seem cheap, giving them a competitive advantage over low-carbon energy sources. On top of the externalized costs of fossil fuels, dirty energy has an additional advantage over clean energy—enormous subsidies. The Environmental Law Institute has found that in the United States from 2002 to 2008 through government spending and tax breaks alone, fossil fuels received \$70.2 billion, more than twice the \$29 billion dedicated to renewable sources of energy.²⁶ These market failures and reversed incentives are currently preventing all components of the five market actors identified in this report from participating in low-carbon development.

The federal government is indispensable in correcting these failures and creating the incentives for collaboration between inventors, investors, manufacturers, consumers, and state and federal energy regulators.²⁷ By coordinating these interests, the goal of a clean energy economy is within reach as an engine of renewed prosperity and industrial growth.

In the pages that follow, we lay out the policies to advance the core needs of each of these key constituencies. First is a call to examine the loosely sewn patchwork of policies influencing American industry and assess American competitiveness across the board. With a strong understanding of policy strengths and weaknesses, the federal government can work to align efforts of various

policymakers and programs across federal, state, and local agencies to more effectively support low-carbon innovation in all industries.

Next are policies to ensure our nation's robust research system is amply supported with public and private money, geared toward solving our energy and climate challenges. We then present policies designed to engage with current and future manufacturers who will create jobs making, marketing, and selling the clean energy technologies that will redefine American industry. Then we discuss ways to incentivize investors to do the work of financing the commercialization and deployment of clean energy technologies.

Finally, and perhaps most importantly, we recognize that markets consist of both supply and demand, and thus present policies to engage with the consumers and end-users of clean energy technology. This constituency represents building owners, power producers, utility companies, automotive fleet managers, and even the car owners, homeowners, and families who must make choices about how to power their lives. Creating incentives for individual consumers and private companies large and small to buy low-carbon goods and services, and efficient, clean energy products is key to accelerating investment in these strategic industries. Public policy will play an important role at every step in this process.

We conclude with a discussion of the human, physical, and institutional infrastructure that is needed to nourish the roots of low-carbon innovation across all industries. This final section offers overarching policies to ensure our society as a whole continues to educate and support the best and brightest researchers, manufacturers, investors, consumers, and policymakers, who together will build the clean energy industries of the future. All five actors will benefit from a workforce well-educated in science, technology, math, and engineering. They will also profit from the availability of essential transportation, electrical, and other industrial infrastructure upon which business and commerce depend.

Our success as a nation and as a planet in transitioning to a prosperous low-carbon future depends on our ability to engage with all market participants through broad-based industrial strategies that maximize the use of existing building blocks in policy and institutions. Well-crafted low-carbon industrial strategies are one key to ensuring our economy is equipped with the right infrastructure and information to support innovation and sustained growth during a time of rising resource constraints and economic pressures.

Our success as a nation and as a planet in transitioning to a prosperous low-carbon future depends on our ability to engage with all market participants.

Given the tremendous pressure on U.S. budgets, these low-carbon industrial strategies must be carefully structured to deliver benefits through existing institutions and market mechanisms by retooling our standing systems of economic development. This infrastructure has served previous generations effectively but is now in need of serious retooling and reinvestment. Our approach establishes the priorities we must address, the principles upon which to proceed, and outlines the unique challenges posed by the U.S. policy context to create jobs and promote a globally competitive economy in a changing environment.

About the Center for American Progress

The Center for American Progress is a nonpartisan research and educational institute dedicated to promoting a strong, just and free America that ensures opportunity for all. We believe that Americans are bound together by a common commitment to these values and we aspire to ensure that our national policies reflect these values. We work to find progressive and pragmatic solutions to significant domestic and international problems and develop policy proposals that foster a government that is “of the people, by the people, and for the people.”

About the Global Climate Network

The Global Climate Network is a collaboration of independent, influential and progressive research and policy organisations in countries key to tackling climate change. Together, members of the Network are committed to addressing the constraints faced by sovereign governments in agreeing international action.

The Network aims to help governments clear a pathway towards an effective and fair international agreement for avoiding dangerous climate change by proposing bold low-carbon policies and using data and analysis to persuade policymakers that climate change mitigation is in their interest.

Center for American Progress



Center for American Progress
1333 H Street, NW, 10th Floor
Washington, DC 20005
Tel: 202.682.1611 • Fax: 202.682.1867
www.americanprogress.org



Andrew Pendleton, Global Climate Network Secretariat
13–14 Buckingham St,
London WC2N 6DF United Kingdom
a.pendleton@ippr.org

