Center for American Progress

Global Climate Network

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Low-carbon Innovation

A Uniquely American Strategy for Industrial Renewal

Bracken Hendricks, Sean Pool and Lisbeth Kaufman May 2011

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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.

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.

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.

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

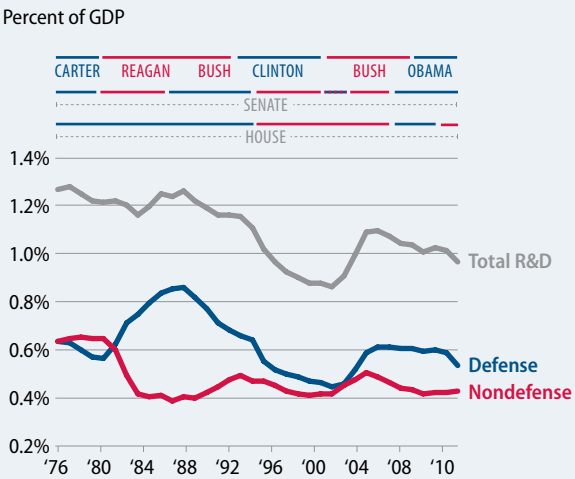
The United States boasts an unrivaled innovation and competitiveness infrastructure, the legacy of unparalleled public and private investments in the 19th and 20th centuries, but unfortunately in recent decades U.S. public commitment to research and development, infrastructure, and business innovation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

Coordinating regulators and researchers

The United States needs a plan to create jobs and sustain long-term growth while driving down its global warming pollution. We must meet both of these goals in tandem. The problems of human-caused climate change are becoming increasingly clear.[28] These impacts pose major risks to the economy, and the justification for prudent decision makers to drive down carbon pollution on purely economic grounds is strong. Increasingly economic forecasting and competitive positioning must include a robust response to the economic and infrastructure challenges that a warming planet creates.

While the risks of inaction on climate are great, so too are the rewards for investing in climate solutions. Reinventing our economy to run more efficiently on clean energy represents a multitrillion-dollar market opportunity for the countries and companies that take the most innovative approaches to mitigating the impacts of climate change through new low-carbon technologies and processes. Low-carbon industrial strategies mean reinvesting and modernizing infrastructure with new technology that is less environmentally harmful. That means new jobs, new businesses, and demand for new manufactured products.

The market for clean energy has been growing rapidly in recent years. The United States leads the world in clean-tech innovation, receiving 75 percent of all venture capital and private equity investments in the sector. U.S. venture capital investments in clean tech increased tenfold over the decade since 2000, amounting to $6 billion in 2010, while clean tech rose from just 1 percent to nearly a quarter of all U.S. VC investments.

Globally, the clean energy sector has witnessed 630 percent growth in investments since 2004, and in 2010 alone the whole clean-technology market grew 35 percent to $243 billion.[29] This is an impressive rate of growth, and real political commitments made by China, many European countries, and numerous U.S. states will ensure the global demand for these technologies continues to create commercial opportunities both in the United States and around the world in both the short and medium term.

By 2020 analysts at the investment banking arm of HSBC Holdings plc recently estimated that the low-carbon energy market will soar to $2.2 trillion a year.[30] The companies and countries that take advantage of this growing demand for clean energy stand to make serious earnings. Given that many clean energy technologies now produced around the world were invented in the United States, this country has a unique opportunity to tap into this growing market. But we need to act fast.

The private sector must play the lead role in driving this innovation and economic transformation, but policymakers in all levels and branches of government have a critical role to play as well. Legislators, governors, and President Obama and his administration must work to enact smart policies that create market conditions that facilitate this transition. In addition, regulators, program managers, and government agencies of all sorts must engage more directly with the private sector as well. That is why we've included them alongside researchers, manufacturers, investors, and consumers as full participants in low-carbon industrial transformation.

The private sector must play the lead role in driving this innovation and economic transformation.

Bringing policymakers and regulators together

Regulation of energy markets in the United States varies widely region by region. Yet across all energy markets, policies, incentives, and market rules play pivotal roles in organizing investment decisions and shaping patterns of innovation. Policies and regulations remain an indispensible part of clean energy industrial transition. With great influence on the plans and decisions of industry, policies and regulations must be transparent and properly coordinated to ensure utmost efficiency and efficacy.

There are already many institutions within the federal government with various responsibilities connected to low-carbon industrial transformation. Dozens of agencies and programs are responsible for fostering economic growth, incubating business development, providing workforce training, and investing in innovation at the project or company level. Involved institutions include:

- The Department of Commerce's Economic Development Administration
- The Small Business Administration
- The Department of Labor
- The National Science Foundation

- The Department of Energy
- The Export-Import Bank
- The Advanced Research Projects Agency—Energy
- The Federal Energy Regulatory Commission
- The Environmental Protection Agency

These and other federal agencies are in addition to the myriad state and local economic, industrial, environmental, and innovation-related agencies and programs.

In developing coherent national clean energy industrial strategies, the trick is to link, leverage, and align these existing systems, programs, and institutions at the federal level to work in concert around core goals of low-carbon industrial transformation, job growth, and long-term economic development that are the common pursuit of state policymakers and the private sector. In a recent report, "A Focus on Competitiveness: Restructuring Policymaking for Results," the Center for American Progress argues that the federal government's policymaking process needs to be much better aligned, and perhaps even reorganized, to focus on a coherent strategy for long-term prosperity—exactly the kind of overarching strategy we are arguing for here.[31]

Conduct a national industrial competitiveness assessment

As a first step in the alignment process, the report emphasizes the need for the United States to do a "horizon scan" to determine exactly where our country is currently most and least competitive. As the report notes:

> *While all federal agencies engage in some form of strategic planning, few perform long-term planning and so-called "horizon scanning," or deep assessments of economic strengths and weaknesses that include explicit future goals and policy implementation plans. And no single agency takes a comprehensive look at the global economic future and our place in it—that is, a look beyond the immediate horizon to the vast array of issues that implicate so many different agencies across government.*[32]

This type of assessment is common among the branches of the U.S. government that already engage in some form of industrial policy or planning. For instance, the Department of Defense does a Quadrennial Defense Review, which is a:

> *… comprehensive examination of the national defense strategy, force structure, force modernization plans, infrastructure, budget plan, and other elements of the defense program and policies of the United States with a view towards determining and expressing the defense strategy of the United States and establishing a defense program for the next 20 years.*[33]

Likewise, state and local governments commonly perform assessments of their particular economic strengths and weaknesses. In fact, the U.S. Department of Commerce's Economic Development Administration, or EDA, often requires that any state or region applying for federal economic development assistance produce a Comprehensive Economic Development Strategy, or "a comprehensive plan that is created through a process that brings together public and private sector stakeholders to provide a regional economic roadmap to diversify and strengthen a regional economy," in order to receive economic development funds from the federal government.[34]

Two recent occurrences have made significant progress to improve the government's awareness of key energy innovation and competitiveness issues. The June 4, 2011, reauthorization of the America COMPETES Act included a provision under Section 604 of that legislation that requires the Department of Commerce to develop a "comprehensive study of the competitiveness and innovative capacity of the United States." This study will assess a wide range of indicators pertaining to our national competitiveness and innovative capacity, as well as identify ways for federal agencies and new legislation to take action to foster innovation and competitiveness.

On March 14, 2011, the Department of Energy announced plans to implement a Quadrennial Technology Review, or QTR.[35] This program will "describe the nation's energy landscape and challenges, identifies important research, development, and demonstration (RD&D) policy choices to be made, and summarizes the current status of selected energy technologies and DOE technology program goals."[36] This will be a welcome addition to the process of coordinating our existing policies, programs, and agencies toward the goals of job creation and low-carbon industrial transformation.

As recommended in CAP's competitiveness report, "A Focus on Competitiveness," we suggest the one-time competitiveness assessment in the America COMPETES Act be made into a permanent, funded, quadrennial

competitiveness review.[37] This would ultimately serve to identify the nation's long-term competitiveness challenges and potential barriers. Ideally, such a scan would include an assessment of the carbon intensity of a wide variety of economic sectors and industries in the United States.

A less ambitious but equally relevant project could be to focus in on our manufacturing sector in particular, to identify existing manufacturing firms, supply chains, and exports. At the moment, no comprehensive survey of manufacturers and products exists, but its creation could be the first step toward a national manufacturing strategy. Both Rep. Daniel Lipinski (D-IL) and Sen. Sherrod Brown (D-OH) have proposed legislation during the 112th Congress asking the Department of Commerce to do this type of assessment and strategy on at least a biennial basis.

Progressive federalism: Working in concert with state and regional policies

Next we need to coordinate and collaborate with state and local policymakers, business leaders, and nonprofit institutions such as universities and community colleges. In many ways, the United States is less a single large economy than a network of interconnected state, local, and regional economies. Any low-carbon industrial strategies must take into account the diverse political landscape, unique economic assets, industrial characteristics, and competitive strengths of different regions and capitalize on them.

Many individual American states have policies and programs that promote clean energy and incentivize low-carbon industries. Any national low-carbon industrial strategies have to build on these, making sure not to undercut any already existing effective plans and currently strong market structures. These measures include mandatory statewide renewable electricity standards in 30 states, voluntary renewable energy savings programs in six states, and other state policies to improve energy efficiency and reduce co-pollutants from sources of carbon pollution.[38]

State measures also involve a broad array of economic development incentives that range from special tax preferences in designated economic development zones to revolving loan funds, to subsidies for site preparation, plant construction, to workforce development. Treating clean energy appropriately as an emerging sector of industry has led to significant investments in states as diverse as Pennsylvania and Nevada.[39]

Then there are the regional efforts. In one dramatic example of multistate action to coordinate policies across a wider subnational region within the United States, 10 northeastern states have forged a regional partnership called the Regional Greenhouse Gas Initiative, or RGGI (pronounced "Reggie").[40] RGGI is a first-of-its-kind agreement among 10 Northeastern and mid-Atlantic states comprising nearly 20 percent of the U.S. economy (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Jersey, New Hampshire, New York, Rhode Island, and Vermont) to reduce their power-sector global warming emissions by 10 percent by 2018 using a market-based mechanism for pollution reduction.[41] While New Jersey's recent withdrawal from the program might be viewed as a setback, RGGI continues to enjoy widespread support in the region and will proceed without the garden state.

Similarly, 13 Western states have joined with seven Canadian provinces and seven Mexican states to form the Western Climate Initiative, which will accomplish similar goals while securing a total of $100 billion in energy-efficiency savings for the regional economy between 2012 and 2020.[42] Better yet, the California legislature recently voted to instate the nation's most progressive renewable energy standard. The bill requires the state's utilities to increase renewable energy generation from 20 percent currently to 33 percent by 2020.[43] The standard will have more longevity and efficacy as a law because it will not be subject to the whims of changing gubernatorial administrations.

These are great examples of how change in the United States often happens from the bottom up. To promote economywide clean energy innovation and low-carbon development, federal policymakers must be careful to ensure national policies integrate with, rather than preempt, state and local action. (See box on page 36 on the importance of California's state energy policies to low-carbon industry formation, job creation, and innovation.)

Empowering clean energy researchers

Research and development are important first steps in the innovation process and will need additional funding if we are to power a low-carbon industrial revolution. Much of the basic and applied research that drives new technology development in clean energy and other research arenas is provided by the federal government. Nearly 60 percent of all basic and applied R&D funding at universities comes from the federal government.[44] More interesting, the National Science Foundation's data suggest that 26 percent of all research and development funding conducted anywhere—from universities to corporate facilities to government labs—is provided by the federal government.[45]

Alas, relative to GDP, total R&D investment in the public and private sectors combined has fallen in the United States behind that of Japan and South Korea.[46] While American trends stagnate below 3 percent of GDP, China's R&D investment has increased from 0.9 percent to 1.5 percent in just the past decade and is poised to rapidly surpass our own.

Additionally, American federal allocations for publicly funded R&D specifically for energy are small compared to the national commitment to the Department of Defense and National Institutes of Health. In 2011 the requested budget authority for Department of Defense R&D was $78 billion, NIH $30 billion, while the Department of Energy received only $11 billion for R&D. Department of Energy R&D funding also hasn't seen any substantive growth like other comparable agencies. All of these figures seem small compared to the $272 billion spent by industry on R&D in 2010. As with health care and defense technologies, we suggest in this paper that clean energy is a public good and our public investment priorities should reflect this.

Sustained federal support is essential for the kind of robust R&D that is needed to fuel innovation in the long run.

Sustained federal support is essential for the kind of robust R&D that is needed to fuel innovation in the long run. The President's Council of Advisors on Science and Technology estimates that America must invest an additional $12 billion annually in energy R&D to lead in clean energy technology to stay competitive with other nations, protect the environment, and ensure energy security.[47] This investment coupled with world-class American research universities, national labs, and grants programs will provide a good start to maintaining American innovative prowess.

But we also need to ensure that the private sector continues to invest in robust research and development activities, and that publicly funded research spending is directed not just toward early-stage basic research but toward the ever-critical production process innovations that help bring down the costs of clean energy. To that end, here are a few policy proposals that ensure public, private, and university researchers serve their vital role in innovation networks fueling low-carbon industrial transformation. Specifically, the federal government needs to:

- Reform the Patent and Trademark Office to make it more efficient
- Strengthen and simplify the federal R&D tax credit
- Leverage our defense industrial base and research infrastructure for clean energy

Let's explore each of these suggested reforms in turn.

Reform the Patent and Trademark Office to make it more efficient

The wait time for patent approval today can be as long as three years. This is unacceptably long for startup companies and small businesses that often need to prove they hold title to their ideas before investors will agree to back them. Rather than address this problem, the 111th Congress diverted $53 million in patent applicant user fees from the Patent and Trademark Office, or PTO, adding to the cumulative $750 million diverted since 1990 for deficit reduction and to fund other, unrelated federal programs.[48]

The PTO desperately needs this revenue stream to increase its bandwidth and process the backlog of nearly 1 million promising new patent applications. This creates a considerable barrier to innovation in all sectors. Congress needs to refund the money it has taken from the PTO and help ensure America is the most attractive place to commercialize new technologies. Doing so will help speed investment in low-carbon technologies and production processes, create jobs, and add to the intellectual capital that will drive our nation's competitiveness in the 21st century.

Recently, the Senate passed the America Invents Act of 2011 with a bipartisan vote of 95-5. This legislation would affect important structural changes to the PTO's authority to manage its own budget; help reduce the backlog and pendency, or wait time, for application processing; and bring the U.S. patent rights system in line with the rest of the international community by changing from a "first-to-invent" system to a "first-to-file" system. This small change could have big implications for increasing the efficiency of our patent system and reducing uncertainty for private-sector researchers, investors, entrepreneurs, and innovators.[49]

Strengthen and simplify the federal research tax credit

In his State of the Union address earlier this year, President Obama echoed a sentiment shared by many in industry that the corporate tax code needs to be simplified. This is certainly true of the research tax credit, which encourages businesses to invest in technology research and development.[50] A large body of literature has shown that investment in R&D is a significant driver of economic growth, with economywide average returns on investment averaging 30 percent or more.[51]

Since 1981 the research tax credit has been renewed by Congress on a temporary basis every two to three years, creating considerable uncertainty for businesses. Congress should make permanent the existing research tax credit.

Additionally, Congress needs to seriously re-evaluate the design effectiveness of the research tax credit. As currently designed, the tax credit offer applies only to marginal research spending above a certain limit. But as the Government Accountability Office notes, a better design may instead be to apply the tax credit to all research spending at any level.[52] Another issue arises around drawing the line where qualified research expenditures covered by the credit stop, and commercialization begins. And other countries have experimented with replacing the standard research tax credit with a "research jobs credit" that essentially subsidizes the wages of accredited scientists and engineers.

As corporate tax reform continues to be a part of the public debate in the coming months and years, Congress should take a hard look at some of these nuanced design characteristics of the research tax credit, with an eye toward minimizing uncertainty. Congress should also consider making the credit more generous, easier to use, and fully refundable, specifically for the small businesses. Small businesses and technology startup companies play an important role in the energy innovation ecosystem in the United States, and the refundability of the research tax credit could affect whether these small firms make it through the so-called "valley of death" to the point of commercial profitability.

Finally, implementation of the tax credit should be better integrated with existing research, innovation, and technology transfer grant and loan programs that exist within the Small Business Administration, the Department of Energy, the National Science Foundation, and elsewhere. Making small companies that receive Small Business Innovation Research grants, Small Business Technology Transfer grants, Technology Innovation Program grants, or any of the various Department of Energy research awards automatically eligible for the research tax credit would simplify the process and decrease uncertainty for small energy companies struggling to bring new technologies to market.

Any increase in cost to these innovation-driving tax incentives should be paid for, as the president himself suggested in his address, by closing other corporate tax loopholes.

Leverage our defense industrial base and research infrastructure for clean energy

The Department of Defense, which includes America's armed services as well as our military technology research operations under the Defense Advanced Research Projects Agency, or DARPA, is the largest consumer of energy in the world. The DOD spent $3.4 billion on energy in fiscal year 2007, the most recent year complete data are available.[53]

This means the military has a big stake as a consumer of energy in creating the opportunity to drive demand for cleaner technologies. What's more, the Department of Defense for many years has been the one part of the U.S. government that has actually conducted what could be viewed as coordinated industrial policy, and this should inform any technology-driven innovation strategies in clean energy.

For the first time, the U.S. military identified addressing climate change as a critical priority for reducing instability and conflict.

For the first time, the military identified addressing climate change as a critical priority for reducing "instability and conflict" in the Quadrennial Defense Review in 2010.[54] The Air Force, Army, Navy, and Marines have all undertaken programs to increase installation of energy-efficiency systems and to utilize emerging renewable energy technologies in military facilities.[55]

A report put out by the Pew Charitable Trusts observed that Navy officials are planning for half of the service's fuel to come from non-fossil-fuel sources by 2020.[56] Meanwhile, the Army is constructing a 500-megawatt solar power generation plant in California, and the Marine Corps has launched a campaign aimed at reducing energy intensity and water consumption, and increasing the use of renewable energy.[57] These efforts will not only help create market pull for clean energy technologies but will also help build new strategic capabilities for our fighters abroad by reducing their dependence on petroleum supply lines. Congress should maintain funding for these efforts as well as ensure the services share ideas and successes.

The Department of Defense has a long history of successfully connecting researchers, manufacturers, and investors with customers for strategically important technology. The DOD Manufacturing Technology Program, or "ManTech" for short, identifies strategically important technologies that need scale and skilled workers in order to attract private investments, and it connects the dots to help drive priority technologies through the innovation lifecycle.[58]

We need to rethink our approach to clean energy technology by recognizing its strategic importance to our nation's long-term economic prosperity and national security. Existing federal agencies from the Department of Energy to the Small Business Administration need to take a page out of DOD and DARPA's industrial innovation strategy playbook.

DARPA's vast operations in basic science, research, development, and commercialization of advanced technologies can be leveraged to begin finding solutions to our energy challenges. Recently, the president signed a law that funded the Advanced Research Projects Agency—Energy, which operates in a way similar to DARPA. DARPA and ARPA-E need to work in closer alignment to share best practices, merge intellectual resources, and coordinate funding priorities.

Specifically, the Center for Naval Analysis released a report in 2010 that produced detailed findings about how the United States' vast physical and institutional infrastructure for developing military technologies can be better leveraged to help drive the clean energy transformation.[59] We support their findings that:

- The Departments of Defense and Energy should more closely align their energy-related research and development activities, funding priorities, and intellectual capital.
- The Department of Defense should formalize the role of its installations and infrastructure as primary test beds for products developed at DOE innovation hubs, ARPA-E, and other research facilities.
- The Department of Defense should require data transparency and widespread sharing of energy information in its research and development enterprise.
- The Department of Defense should [continue to] include acquiring clean energy technologies as a priority in its installation acquisition strategy.

In sum, then, our proposal for low-carbon industrial strategies must entail highly collaborative and coordinated efforts by federal and state policymakers working closely with the private sector and universities—a progressive federalist policy platform that can bring manufacturers in the clean-tech arena together around big ideas and grand ambitions and help them realize those dreams for the good of our nation. To this we now turn.

Mobilizing clean energy manufacturers

The United States is still the world's largest manufacturer—at least for another few months. But this year our great nation will cede the position of world's No. 1 manufacturer—a title it has held for more than a century—to China.[60]

Any low-carbon industrial strategies must include investing in our capacity to manufacture clean energy goods as well as to produce traditional goods in less-carbon-intensive ways. This kind of innovation is the key to our long-term competitiveness and to making affordable the technologies that will increase our energy security. But it does not only happen in the laboratory. In reality, innovation happens across a spectrum of activities beginning in the lab, but happening equally robustly on the factory floor.

As important as R&D investments are, manufacturing itself deserves equal attention, notes General Electric Company Chairman and CEO Jeffrey Immelt, the new chair of the President's Council on Jobs and Competitiveness, in a recent op-ed.[61] In recent years many companies have shifted manufacturing overseas to take advantage of other countries' low labor costs or the significant subsidies offered by other countries' aggressive industrial competitiveness policies. As the Harvard Business Review points out, offshoring manufacturing to other countries ultimately erodes our ability to make high-tech products and to invent new ones.[62]

In a speech last year, Jared Bernstein, then the chief economic policy advisor to Vice President Biden, also pointed out the relationship between R&D, manufacturing, and innovation when he said:

> *Manufacturing firms are responsible for 70 percent of the research and development undertaken by private industry in the United States. Seventy percent occurs in manufacturing. So from the critical perspective of innovation, which means a lot to this president, to lose our manufacturing edge is to lose our cutting edge.*[63]

This is because when a country loses manufacturing expertise, it also sheds design and R&D capabilities with that expertise.

Christian Weller and Luke Reidenbach of CAP note in their recent report, "The Case for Strategic Export Promotion," that the United States has seen its balance of trade in high-tech sectors such as aircraft, precision instruments, pharmaceuticals, and computer and information technology drop from a surplus in the 1990s to a deficit representing nearly 0.6 percent of GDP in 2009.[64] This loss of high-tech manufacturing capability will cost us more than just billions of dollars in trade revenue; it will strip us of our ability to innovate and create jobs in the long run.

A low-carbon industrial strategy must support manufacturing technology in the United States to keep the product and process knowhow in the country. Manufacturing is critical to sustained innovation, job retention, and long-term economic health. As Michael Ettlinger and Kate Gordon point out in their recent paper, "The Importance and Promise of American Manufacturing," wages "aren't everything."[65] Other factors, among them proximity to markets, skilled labor, and research and management resources are also important. Here are a few policies to help engage with our nation's manufacturers to create jobs by producing the clean energy technologies needed to transform our nation's industries.

Conduct a comprehensive clean energy manufacturing assessment

Step one in engaging American manufacturers in the clean energy industrial transformation is to conduct a comprehensive national assessment to identify existing manufacturing firms, supply chains, and exports. The Manufacturing Extension Partnerships, a network of 59 regionally focused manufacturing centers, work to coordinate manufacturing at a local level. But at the moment, no comprehensive, national survey of manufacturers and products exists; its creation could be a first step toward integrating the nation's manufacturing strategy.

Reps. Daniel Lipinski (D-IL) and Frank Wolf (R-VA) have co-sponsored legislation in the 112th Congress that would require the Department of Commerce to conduct just such an assessment on a biennial basis. The bill's stated goals are to "increase overall domestic manufacturing, create private-sector jobs, identify emerging technologies to strengthen American competitiveness in the global marketplace, and identify a strategy for repatriating jobs to the United States."[66]

In the Senate, Sen. Sherrod Brown (D-OH) recently introduced the Security in Energy and Manufacturing Act, or SEAM Act, which includes similar provisions, in addition to extending the critical 48(c) advanced manufacturing tax credit for qualified investments in advanced energy projects, to support new, expanded, or re-equipped domestic manufacturing facilities and is discussed in more detail below.[67] These kinds of steps by the federal government would help states boost their own innovation capabilities in clean energy, akin to steps taken by the state of Michigan in recent years. (see box)

Reestablish and expand the clean energy manufacturing tax credit

Since its introduction in the Recovery Act of 2009, the section 48c Advanced Energy Manufacturing Tax Credit proved to be an effective tool to reinvigorate our manufacturing base. There is certainly private-sector appetite for it: The

Low-carbon manufacturing renaissance in Michigan

The "Great Recession" has not been kind to Michigan. While automotive giants Ford Motor Co., Chrysler Group LLC, and General Motors Corp. were already struggling, the economic climate continued to hammer the entire state and drive unemployment to more than 15 percent.[68] In a bold and desperate move to save the state of Michigan and the Big Three from economic ruin, former Gov. Jennifer Granholm drafted several policies and invested heavily in promising low-carbon manufacturing industries.

Capitalizing on Michigan's existing manufacturing base, Gov. Granholm invested $6 billion to catalyze the formation of a regional advanced battery manufacturing industrial cluster. A cluster is a geographic concentration of companies, suppliers, service providers, and institutions involved in a particular field or industry; in this case advanced batteries. This initial investment accelerated the creation of 16 advanced battery makers in Michigan and created 62,000 jobs. It also brought together researchers at the University of Michigan with GM to provide research facilities.

The organization of different innovation participants around a common goal is helping drive the development and commercialization of a new generation of American-made electric vehicles. With the plug-in hybrid Chevy Volt already in production in Detroit, Michigan may be at the cutting edge of low-carbon automotive technology thanks to the state's innovation-oriented low-carbon industrial policies.[69]

But it's not just cars. Taking advantage of federal grants and subsidies in the American Recovery and Reinvestment Act of 2009, the state of Michigan attracted $4.1 billion in public and private investment in the solar industry, boosting employment in that field to nearly 6,300, fourth highest in the entire United States.[70] Additionally, manufacturers of wind turbines have pledged to produce their products in Michigan.[71] Citing the inevitable, Gov. Granholm says that since "people are going to make this stuff," the goal has been to have this "stuff" consisting of batteries, electric cars, solar panels, and wind turbines, all made in Michigan.[72]

Neither this emergent clean car innovation cluster nor Michigan's growing manufacturing industries in solar and wind would have been possible without targeted federal policies geared towards engaging manufacturers in clean energy innovation. It is time we learned from the success of this and other examples and created a federal strategy to accelerate regionally based, innovation-driven low-carbon industrial growth.

White House has noted that the program was oversubscribed by a ratio of more than 3-to-1, reflecting "a deep pipeline of high quality clean energy manufacturing opportunities in the United States."[73]

But Congress recently allowed this successful program to lapse despite the thousands of jobs it helped create or save and the billions of dollars in private capital it helped channel into 183 innovative clean energy manufacturing projects in 43 states.[74] Congress needs to act quickly to extend the program for 5 to 10 years, ensuring it phases out with a predictable sunset path. This requires budgeting an additional $5 billion in tax credits for the program and enhancing the credit to place more emphasis upstream on component manufacturing rather than final assembly. This will help small businesses because, according to 2007 U.S. Census data, the majority of small- to mid-size manufacturing companies across the United States are parts suppliers rather than assemblers.[75]

Finally, in addition to expanding the tax credit and making it more long term, Congress should also incorporate a cash grant in lieu of tax credit policy for this revamped manufacturing tax credit. Offering the incentive as a cash grant instead of a tax credit would help fulfill our immediate national priorities of short-term job growth and make the incentives more enticing to private-sector investors and developers, many of whom have little or no tax liability in today's gradually recovering fiscal environment. The section 1603 cash grant program currently does this for the federal investment tax credit, and it has been successful in attracting private capital.[76]

A recent report by the Center for American Progress, "America's Hidden Power Bill," examines federal energy tax expenditures.

A recent report by the Center for American Progress, "America's Hidden Power Bill," examines federal energy tax expenditures. Authors Richard Caperton and Sima Gandhi find that incentives in the form of tax credits are problematic because they "suffer from a lack of transparency, evaluation, measurement, and oversight."[77] This is why cash grants are preferable in our estimation, and also in the view of the findings of the Bipartisan Policy Center, which recently published a study finding cash grants are roughly twice as effective as tax credits in attracting private capital for solar and wind power projects.[78]

It would not be a stretch to assume the same would hold true for the manufacturing tax credit for clean energy equipment manufacturing projects. The Security in Energy and Manufacturing Act of 2011, or the SEAM Act, as introduced by Sen. Sherrod Brown (D-OH) in the Senate and Rep. Steven Rothman (D-NJ) in the House would address these goals and should be used as a model as Congress considers energy legislation moving forward.[79]

Create revolving loans to help manufacturers invest in efficiency and clean energy

Three pieces of legislation introduced but not passed in the 111th Congress can serve as models for future action to increase the energy efficiency of our industries, as well as to help manufacturers invest in producing clean energy technologies. The Investments for Manufacturing Progress and Clean Technology Act of 2009, or IMPACT, would provide $30 billion in revolving loans to assist small- and medium-size firms as they retool, expand, or establish domestic clean energy manufacturing operations, or make their existing firms more energy efficient.[80] IMPACT would also provide new funding sources for the Manufacturing Extension Partnership program, discussed below, which provides technical assistance to manufacturers hoping to become more productive, efficient, and competitive.

The eastern Midwest regional manufacturing cluster

A number of regional industry cluster organizations have sprung up in the eastern Midwest region of the United States, from Youngstown, Cleveland, and Akron, OH, to Pittsburgh, PA, and Wheeling, WV. Facing the steady decline of skilled manufacturing jobs, these cities have decided to shift gears and reinvigorate their economies by coordinating different kinds of innovation participants in the advanced manufacturing sector. Unlike other regions that may have to build entirely new infrastructure to handle the new clean technology, this area is unique in that it already has a highly developed manufacturing sector.

These regional industry clusters capitalize on historical assets in human and physical infrastructure that make them "highly innovative and linked to R&D capabilities that are stable, not the highly risked boom-bust types," according to Science Progress's report, "Silos of Small Beer: A Case Study of the Efficacy of Federal Innovation Programs in a Key Midwest Regional Economy."[82] The public-private partnerships that have emerged without federal coordinating support are designed to enhance cooperation in research, innovation, and commercialization by aligning the activities of policymakers, researchers, manufacturers, investors, and consumers.

One case in point is Innovation Works, an investor in seed-stage companies in southwestern Pennsylvania's technology economy, which provides investment and business assistance to high-growth companies in the area.[83] Similarly, BioEnterprise, a business formation, recruitment, and acceleration initiative designed to grow health care companies and commercialize bioscience technologies in Ohio, supports bioscience commercialization by creating, attracting, and accelerating the growth of high-potential bioscience businesses.[84] As a measure of success, more than 8,600 published U.S. grants were filed in the region from January 2006 to May 2010.[85]

Seeking to redefine themselves, the major cities in this region have sought to brand themselves not the Rust Belt, which dominated their image in the 1970s and 1980s, but instead as the Tech Belt.[86] They want to use their existing assets and infrastructure and take advantage of the region's large concentration of researchers and engineers to facilitate the transition toward a more technology-based economy. With targeted federal support, local, bottom-up, and job-creating industrial initiatives like these can help hard-hit American communities lead in innovating our way to a low-carbon economy.

A smaller bill, the Restoring America's Manufacturing Leadership Through Energy Efficiency Act, would provide up to $100 million in revolving loans to help commercial and industrial manufacturers make their facilities more energy efficient.[81] The act also would provide new funding for research and development into new manufacturing technologies and processes.

These policies are important for moving private capital into job-creating, innovative new clean energy industries and markets, and for ensuring the robust supply chains for clean energy manufacturers. While both of these bills were held up in the 111th Congress, they serve as excellent models for cost-effective legislation moving forward. Taking such steps will help regional manufacturing centers flourish across the nation. (see box)

Double down on the Manufacturing Extension Partnership

The Manufacturing Extension Partnership of the U.S. Department of Commerce provides manufacturing companies with a wide array of fundamental services, helping them to access cutting-edge technology and become more efficient and competitive in global markets. The MEP "works with partners at the state and federal levels on programs that put manufacturers in position to develop new customers, expand into new markets and create new products."[87]

The MEP has a record of success in all three of our national industrial policy priorities. For every $1 of federal investment, it generates on average $32 in new sales growth, helping build markets for the technologies that will power our future.[88] What's more, every $2,000 invested in the MEP program creates one private-sector American job, making it a potent remedy to the tool belt recession, felt hardest by manufacturers and construction workers.[89] Unfortunately, the recently passed FY 2011 continuing resolution cut the MEP budget from $124.7 million in 2010 to $44.9 million.[90]

Instead of cutting funds for this vital program, Congress needs to increase its funding, reduce or rework local matching requirements, and instruct the SBA-run small business innovation grant programs, DOE-run research programs, and the Export-Import Bank to actively engage with the MEP to tap into its local networks, databases, and technical knowhow. This will help catalyze industry cluster formation around key areas of national priority such as clean energy.

Rewire the U.S. Export-Import Bank to achieve strategic clean energy export goals

Ensuring access to foreign export markets is a key strategy to foster domestic manufacturing, innovation, and job creation. Research conducted by the World Resources Institute finds that foreign demand for clean energy technologies could amount to $27 trillion over the next four decades, and capturing a modest share of this export market would create nearly a million American jobs.[91] Christian Weller and Luke Reidenbach suggest in their report, "The Case for Strategic Export Promotion," that increasing exports depends on both fostering trade with key partners in high-tech export sectors where the United States is already strong, as well as expanding exports in new industries—of which clean energy is a clear priority.[92]

The history of industrial development is crowded with examples of government-led export assistance as a way to increase demand and output for critical domestic industries.

The Ex-Im Bank's export assistance programs and credit enhancement services have the potential to support U.S. manufacturers in job-rich clean energy industries by proactively seeking to link latent production capacity at home with strong overseas markets where demand is strong. As a taxpayer-supported entity, the Ex-Im Bank has a mandate that extends beyond the short-term viability of its particular investments. It can also target investments that meet the broader public-interest goal of ensuring our nation remains competitive in emerging industries that have the potential to create significant numbers of new jobs over the long run.

The history of industrial development in the United States and across the world is crowded with examples of government-led export assistance as a way to increase demand and output for critical domestic industries. Scaling up a diverse and innovative U.S. clean-tech sector for the 21st century could similarly benefit from this proven path.

Helping ensure access to robust clean energy export markets is a crucial component of fulfilling the national priorities of job creation, innovation-driven competitiveness, and energy security. Regardless of financial support for R&D, production, or demonstration of clean energy technologies, innovative development requires sufficient private-sector demand to remain self-sustaining. The Ex-Im Bank needs to expand its low-carbon policies and environmental export programs by linking them more closely with the grant programs administered by the Small Business Administration and the Department of Energy, and especially with the regional Manufacturing Extension Partnership programs. In this way, investors in clean energy would be further encouraged to put their money into these kinds of manufacturing projects, as our next section will demonstrate.

Incentivizing clean energy investors

Building a strong, competitive low-carbon economy is a vast undertaking on a global scale that will engage the entire economy. Unlike China, in the United States private investors will be behind the wheel in driving industry toward competitive clean-technology growth. But there are major regulatory and market barriers to private capital investments in clean energy and low-carbon industries. As GE's Immelt said in a recent op-ed, "government can help business invest in our shared future."[93] Well-coordinated government policies that set incentives and "crowd-in" private capital investment in low-carbon development are essential to strong industrial strategy.

There are a variety of structural obstacles preventing adequate investment in clean energy, which will be the foundation of low-carbon growth. These include:

- Major clean energy projects require high capital expenditures with a long amount of time required for even modest returns.
- Because many clean energy technologies are relatively new compared to their fossil-fuel counterparts, they are perceived as high risk.
- Federally funded research and development is not fully matched by industry R&D.
- Business models are jeopardized by volatility in commodity pricing.
- Without a price on carbon or a definitive clean energy standard, the policy uncertainty increases risks for clean energy projects.
- Renewable energy must compete on an uneven playing field with incumbent fossil-fuel energy sources which have enjoyed decades of greater federal support and have thus benefits of scale economics.
- The most prevalent incentive for renewable deployment so far has been tax policies, which is a problem for many projects because they have no use within the project for tax benefits and must seek tax equity elsewhere, which can be cumbersome and costly.

Strong low-carbon industrial strategies must include policies to remove these barriers and mobilize private capital. Policies could include loan guarantees, policy insurance, a foreign exchange liquidity facility, pledge funds, or subordinated equity funds.

A Center for American Progress and Global Climate Network joint paper, "Leveraging Private Finance for Clean Energy," goes into these financial tools in greater detail, exploring how public funds could be used to leverage far greater amounts of private investment in clean energy projects.[94] Taken together, the tools can be divided into two distinct categories. Loan guarantees, policy insurance, and foreign exchange liquidity facilities make up the first category and are designed to reduce the risk to lenders and are therefore most accurately termed debt-based mechanisms. The second category includes pledge fund and low-carbon fund with subordinated equity, which can help increase equity investment.

Adding to that list, here are a few other policies that policymakers should consider as they work to ensure private markets drive a sustainable, profitable, and job-creating transition to a clean energy economy:

- Unlock private investment by establishing a Green Bank.
- Accelerate investment in deployment with an Energy Independence Trust.
- Retool existing small business grant programs to focus on innovation.
- Create incentives and remove barriers to private investment in the tax code.

We'll briefly detail each of these policies below in turn.

Establish a Green Bank to unlock private investment

A "Green Bank," a version of which has been proposed in legislation under the name Clean Energy Deployment Administration, or CEDA, could be capitalized at $10 billion to help drive $50 billion or more in private-sector finance each year and create thousands of new innovation jobs in the clean energy economy.[95] CEDA legislation was passed by the Senate Energy and Natural Resources Committee in June 2009 with bipartisan support but unfortunately has not moved further, and it was included in comprehensive energy and climate legislation passed in the full House of Representatives as well.

By creating a fund to extend credit enhancement to investors, CEDA would increase access to capital for clean energy entrepreneurs and help get new technologies through the so-called "valley of death," where entrepreneurs with commercializable products cannot get the financing they need to begin market-scale manufacturing. Credit support would include direct loans, letters of credit, loan guarantees, and low-cost insurance.

Such an institution could also act as a vehicle for coordinating many of the disparate programs listed above, helping to craft a more comprehensive policy framework. As we discuss at length in this paper, there is a patchwork of different policies currently in place to engage and facilitate activity among a broad range of clean energy innovation participants. Since the overall goal of clean energy innovation and competitiveness policy is to encourage increased engagement and interaction among these different market actors, the development of a Green Bank to serve as a clearinghouse for publicly backed credit enhancements could help maximize the benefits of presently uncoordinated activities.

If given the proper authority from Congress, CEDA could play a central role in coordinating these disparate incentives and programs. For example, by aligning Manufacturing Extension Partnership activities with Ex-Im Bank export assistance with credit enhancement from the Energy Independence Trust (described below) for domestic clean energy projects, CEDA could help catalyze both supply and demand simultaneously while engaging with investors and cutting down on compliance costs to all of the above. This kind of coordinated effort within capital markets could attract much greater private investment to emerging clean energy industries.

Accelerate investment in deployment with an Energy Independence Trust

As proposed in a report by the Center for American Progress and the Coalition for Green Capital, the Energy Independence Trust, or EIT, is a further extension of the Green Bank concept focused specifically on commercial-scale deployment challenges facing mature technologies.[96] An Energy Independence Trust, also called an Energy Investment Fund, would be chartered as a nonprofit independent lending institution that would work in concert with CEDA, providing low-cost funding with a specific focus on near-term and widespread deployment of already commercialized clean energy and energy-efficient technologies.

The EIT is designed to complement the Clean Energy Deployment Administration. The two differ in a number of ways. While CEDA would foster initial commercial deployment of breakthrough technologies, the EIT would support the next step in developing clean energy: widespread deployment of proven, commercially ready clean energy technologies, which also face market barriers. The EIT follows up CEDA's support for overcoming the valley of death in commercialization to ensure technologies and projects make it all the way to deploy-

ment achieving economies to reduce costs and drive market penetration at scale. Additionally, while CEDA would sit within the DOE and bring R&D closer to market entry, the EIT would be a publically chartered but privately run financing entity, not unlike the Ex-Im Bank.

By loaning funds at only a few basis points above U.S. Treasury rates, the Energy Investment Trust would reduce the cost of capital for large-scale deployment projects, making more clean energy projects competitive in the market at current energy prices. This in turn would create a larger market for clean-tech goods manufactured in the United States, helping to scale domestic businesses and jobs, akin to what is happening in California today. (see box)

California leads the way on clean energy policy and clean energy investment

To deal with rising energy costs and demands, rising greenhouse gas emissions, and state budget constraints, in 2006 California passed the California Global Warming Solutions Act, or AB 32, by far the most progressive piece of energy legislation in the country.[97] AB 32 creates a carbon emissions pollution trading system, a tailpipe emission standard, and a clean energy standard recently raised from 20 percent to the current goal of 33 percent by 2020. AB 32 notably has strong business support within the state because it has helped organize the market and provide certainty to investors. Support for this measure was further ratified in a recent election through public rejection of a ballot referendum proposing to suspend its implementation.

By creating strong incentives for users of clean energy goods and services, AB 32 has had a tremendous impact in driving demand for new technology and increasing the state's clean energy industries and innovation networks. Google Inc. CEO Eric Schmidt said the Global Warming Solutions Act has been an "incubator of innovation … leading to new job creation in many sectors as business responds to the need for energy-efficient buildings, transportation and a growing portfolio of renewable energy resources."[98]

Thanks to the long-run market signals and robust demand created by these state policies, venture capitalists have invested more than $9 billion in clean energy innovation in California. Venture investments in small, innovative companies remains one of the best ways to stimulate economic growth as venture capital investments create six times the jobs per dollar when compared to direct federal spending.[99] Overall, the effect is clear, as clean energy jobs have grown 10 times faster than the statewide average since 2005, reaching more than 125,000 today.[100]

What's more, these investments have supported the growth of more than 12,000 clean energy businesses and 1,400 new clean energy patents, roughly a fifth of the nation's total.[101] Even in the chilly investment climate of 2009, these clean energy businesses saw $2.1 billion in venture capital investment, which comprised 60 percent of all such investment in North America.[102] These policies have paid off for California, helping it advance all three of the national priorities of jobs, long-term competitiveness, and increased energy security.

There is an old saying that says "as California goes, so goes the nation." With the largest population and largest economy of any American state, California often sets an example for the rest of the nation by passing policies later adopted by the federal government. Congress should pay heed to the benefits these state policies and standards have delivered to Californians.

Retool existing small business grant programs to focus on innovation

Small businesses are major job creators in the U.S. economy and a major source of technology innovation.[103] Recognizing this, the Kauffman Foundation concludes that "effective policy to promote employment growth must include a central consideration for startup firms."[104] We agree. Supporting entrepreneurial startup companies is a critical ingredient to ensuring diverse innovative clean energy technologies have the chance to compete based on their technical and economic merits.

The National Science Foundation, the Economic Development Agency, the Small Business Administration, the Department of Labor, and the Department of Energy each have programs that help small businesses commercialize new technologies. The problem is that these programs are small and dissociated. As we continue to head down the path of a knowledge-based, innovation-driven economy, our small business and industrial priorities need to be more focused and efficient to become more effective.

Small Business Innovation Research, or SBIR, grants; Small Business Technology Transfer, or STTR, grants; i6 Green Challenge Grants; and the Technology Innovation Program, or TIP, are four federal government programs designed to help private investors put money into fledgling technology startups. Small Business Investment Companies are another program designed to leverage private capital with backing from the Small Business Administration toward qualifying small startup companies that meet certain requirements.[105]

The Small Business Administration announced in early 2011 that it would be opening up $1 billion in matching SBIC loans for qualifying clean energy investments, and also providing a five-year delay on the interest of those loans to make it easier for small startup companies to grow.[106] These programs are discussed in more detail on page 53.

These programs provide critical funding for young startup companies with promising innovations to help them bridge the "valley of death," the gap in financing when companies are not profitable enough to attract private capital but too far along for other forms of public or private funding. But these various innovation funding programs are currently scraped together from a patchwork of spending and contract authorities given to the Department of Commerce, the Small Business Administration, and Economic Development Administration by

Congress. Their impact is currently limited by both their lack of coordination as well as their very modest scale (the i6 Green Challenge, for example, provides only $12 million to be split among six winners).

The i6 Green Challenge provides a good model, however, for how these programs can be best administered, though its scope is currently limited. The i6 Green Challenge brings together resources and expertise from five different federal agencies (the Department of Commerce, the Environmental Protection Agency, the U.S. Department of Agriculture, the Department of Energy, and the National Science Foundation) to coordinate on grant applications and help select winners with the best potential.[107] This program is also a model in that it encourages universities, entrepreneurs, and economic development organizations to form collaborative partnerships rather than just putting money into the hands of one actor, and also integrates with the SBIR grant program. But even this new and exemplary program is hindered in what it can accomplish due to uneven spending authorities granted to the various departments.

Congress should pass legislation that makes it easier for agency officials to obtain waivers to allow them to better integrate these programs with each other and with other funding opportunities. Increasing the flexibility of these startup funding programs would allow the agencies involved to coordinate the incentives around bigger-picture goals of innovation, emissions reduction, and job creation. One example of how this improved coordination could work would involve funding applicants with complimentary business plans and technologies. For instance, linking a company developing low-cost solar manufacturing processes with a company that is helping market small-scale solar panel projects. This collaborative approach would reduce risk, facilitate investment, and create jobs.

Level the tax incentives playing field

While oil and natural gas continue to receive numerous specialized tax incentives, clean energy research, development, commercialization, and deployment receive no such advantages.[108] A couple of simple tax code changes would help augment the existing activities of entrepreneurs and investors in new energy technologies.

First is a key proposal to modify the tax incentive for energy-efficiency investments in commercial buildings, known as section 179-D of the federal tax code, which is a seldom-used tax deduction for energy-efficiency retrofits. As part of its "Better

Building Initiative," the White House has proposed to make this tool more broadly available to a range of real estate investors, and to transform the tax benefit into a tax credit, making it a more usable and powerful incentive. Not only would a credit have three times the economic value for building owners, but it would also extend the benefit to real estate investment trusts, or REITs, which are publicly traded real estate portfolios, to attract more investment in clean energy projects.

Second would be to make the Master Limited Partnership tax status accessible to clean energy infrastructure projects. Master Limited Partnerships, or MLPs, are a legal structure that offers significant tax benefits to existing pools of investors in fossil-fuel projects. The MLP tax status allows investors backing special fossil-fuel-related infrastructure projects such as natural gas pipelines to pay taxes at the lower rate of a partnership instead of the higher corporate tax rate.

MLPs would be a very attractive tool for encouraging clean energy infrastructure investment as they provide the tax benefits of a limited partnership, with the liquidity of a publicly traded security. Under current law, however, renewable energy and energy-efficiency projects are excluded from using this investment structure. The fact that this special tax status is available to fossil-fuel energy projects but not to equivalent renewable ones puts clean energy at an irrational disadvantage.

Extending this tax treatment to clean energy investments would help level the playing field for clean-tech companies and create stronger incentive to invest in deploying new technology. In the current Congress, clean energy advocates are working to expand access to the MLP tax status to renewable energy and energy efficiency as well.

Extending this tax treatment to clean energy investments would help level the playing field for clean-tech companies and create stronger incentive to invest in deploying new technology.

Going one step further, considering the nearly century-long record of special taxpayer-funded subsidies for oil and gas, as well as the urgency with which scientists say we must begin to transition away from fossil fuels and toward clean energy to prevent dangerous climate disruption,[109] it might even make sense to consider a blanket tax credit for investors in clean energy startup companies. The existing clean energy manufacturing tax credit and investment tax credit work well for manufacturing and deployment of existing technologies. But why not also reward investors for putting their money into promising startups in early stages of the innovation lifecycle? A clean energy innovation tax credit that rewarded investors for seed-stage and early-stage investment in clean energy would enable investors to invest in low-carbon technology with an eye on delivering the kind of products and services consumers want to buy—the subject of our next section.

Engaging clean energy technology consumers

The last but certainly not least of the five essential participants in clean energy innovation and industrial transformation are consumers of clean energy products and services. Technology change requires a healthy market and strong demand for new and more advanced products. Increased demand for low-carbon products accelerates the production and improvement of those products, and signals to capital markets that clean energy is a good place to invest. While putting money into R&D and helping manufacturers invest in production facilities are important, incentivizing demand for the technologies is one of the most essential but frequently most overlooked components of a successful industrial strategy.

That is why the consumers or end-users of low-carbon technology and goods are perhaps the most important participants to engage in clean energy innovation networks. The solar panel maker cannot succeed without the homeowner, business owner, or utility manager who buys those panels and the electricity they produce. Low-carbon industrial strategies must include policies that ensure users of low-carbon goods and services have incentives to purchase them and the ability to reap the benefits of operating them.

Targeted incentives and effective market structures for engaging the people who buy and use clean energy technologies are essential for innovation. With scaled production and lower prices, manufacturers can afford to develop new and better ways to make a product, consumers of a device can begin to use it in new and different ways, and investors will be more inclined to put money into emerging business ventures.

CAP's recent report, "Leading in the Clean Energy Deployment Challenge," explains in detail how building markets and wide-scale deployment can further advance technological development, but here are a few policy proposals from that paper that can help build markets for clean energy by engaging with the users of new technology.[110]

Engaging the market in recognizing the true cost of pollution

Addressing market distortions and imbalances in pricing of traditional energy helps create demand for low-carbon industries. Existing distortions lead to an overemphasis of harmful and polluting technologies within the market that make the overall economy less efficient and less productive. For instance, coal is inexpensive only because our system doesn't account for its externalized costs such as greenhouse gas emissions released into the atmosphere and harmful pollutants inhaled by our citizens.

How costly is coal to our society? A National Academy of Sciences study found that total annual external health-related damages from sulfur dioxide, nitrogen oxides, and particulate matter created by 406 coal-fired power plants in America amounts to $62 billion in health damages.[111] Excluding damages related to climate change, ecosystem deterioration, and national security, the report found that health-related damages associated with electricity generation and motor vehicle transportation totaled to $120 billion in 2005 alone. These hidden costs translate into suffering among millions of Americans across the country. Plus this massive economic burden is hoisted onto the backs of Americans and businesses, sucking up much-needed private and public resources that could be more usefully invested elsewhere, and ultimately hurting the global competitive positioning of our economy.

Significant emphasis in the United States in recent years has focused on creating a market for carbon pollution by requiring polluters to pay its true cost. The idea was to use the resulting revenues to invest in the conversion to low-carbon industrial production and shift our energy supply toward cleaner technologies. Ensuring the damages of atmospheric carbon are represented in pricing can help investors, innovators, and manufacturers to invest in reducing it.

Creating a market for carbon—in which the federal government would set a cap on carbon emissions and then let polluting industries compete to reduce emissions in the most cost-effective manner—or a range of other policy-driven strategies would create incentives for energy users to purchase more efficient buildings, vehicles, and equipment, and for utilities to invest in cleaner generation. This would be a long-term driver of private-sector finance for clean energy activities and would shift the price incentives faced by consumers as they make their purchasing decisions. This would ensure low-carbon goods can compete fairly in the market relative to high-carbon alternatives.

Furthermore, it would signal to the investment community that the clean energy sector is ripe for long-term growth, and unleash billions of dollars of private investment in new businesses, new infrastructure, and new jobs, driving down the cost of clean energy.

The recent defeat of cap-and-trade legislation in Congress is a significant setback for such market-based strategies for clean energy industrial conversion. Still, the strategy deserves mention as a key pillar of serious low-carbon industrial strategies. It is also proving to be an effective strategy in a number of states and regions throughout the country where state climate policies and multistate compacts are working to help build clean-tech industries and curb pollution.[112] (see page 19)

The recent defeat of cap-and-trade legislation in Congress is a significant setback for such market-based strategies for clean energy industrial conversion.

Even in the absence of new national legislation, subnational climate policies, combined with the threat of potential federal regulation by the Environmental Protection Agency, continue to affect investment decisions. These disparate programs, however, ultimately offer a weaker price signal than federal legislation would provide.

Signal market demand through renewable energy and efficiency standards

While much of the national political attention has been placed on the question of whether and how to put a price on carbon pollution, it is equally if not more important to advance policies that make clean energy cheaper and more accessible to consumers. Chief among these market-shaping policies is the use of regulatory standards to provide a predictable pathway forward for energy companies to anticipate and plan for growth of clean-energy demand. Renewable energy standards and energy efficiency resource standards are used in more than half of U.S. states today. These policies provide much needed market certainty, which in turn makes projects financeable, further decreasing costs and accelerating market growth.

As a Center for American Progress report, "Helping America Win the Clean Energy Race," explains, in the electricity sector, a renewable energy standard, or a properly designed clean energy standard, creates a guaranteed market for clean electricity by requiring that utilities across the nation generate a set percentage of electricity from low-carbon energy sources.[113] Such standards significantly improve the ability to finance and build new projects, resulting in a larger and

more stable domestic clean energy industry. A 2009 Union of Concerned Scientists report, "Clean Power, Green Jobs," for example, found that a renewable energy standard of 25 percent by 2025 could create nearly 300,000 jobs.[114]

Going one step further, the president in his State of the Union address called for a clean energy standard of 80 percent by 2035, covering all U.S. electricity production. CAP analysis emphasizes that to achieve low-carbon industrial-strategy goals through a clean energy standard, Congress would have to include additional internal targets specifically shaping market demand for renewable energy and efficiency.[115] CAP also highlighted how regional flexibility could allow national clean energy targets to best build local industries. Congress needs to heed this call and pass a bill that makes this a reality.

Use the tax code to reduce clean energy costs and increase capital availability

Developing the demand for clean energy technologies will help ensure for growth in the related research, manufacturing, construction, and business jobs such projects create. One way to increase demand is to make it easier for utilities to finance, permit, and install clean energy-generating equipment.

The fact of the matter is that while clean energy generation has no or low fuel costs, it is more capital intensive than fossil-fuel-powered alternatives. This means they must obtain more financing upfront, while having lower costs over the operating life of the facility, than fossil-fuel power plants. Further, clean energy developments tend to pay higher interest rates on these greater upfront investments. Taking concentrated solar energy projects as an example, a recent National Renewable Energy Laboratories report pointed out that:

> *For example, if a conventional fossil power plant were required to purchase all of its fuel up-front and the fuel were treated as a capital investment from a tax and financing standpoint, the cost of power would be more than double. If this up-front capital investment penalty could be eliminated, [concentrated solar] power could compete directly with the most advanced and efficient fossil fuel technologies.*[116]

State public utility commissions must approve new renewable energy installations before renewables can come on-line and before energy providers can recoup the

costs of construction through electricity rates. As a result, tax-based policies that affect overall project costs can help ensure renewable energy projects pass state cost-benefits tests for consumer protection and also make these projects more attractive to private investors. This in turn would increase demand for manufactured clean energy-generating equipment.

While there are countless special tax breaks in place for fossil fuels,[117] fewer special tax incentives exist to facilitate clean energy generation. Two key tax policies have proven to be the lynchpins of renewable energy markets in the United States to date, especially when paired with renewable energy standards. Renewable energy has benefited from a federal investment tax credit and a production tax credit. The federal investment tax credit, or ITC, provides investors who back renewable energy projects with a credit based on their capital investment, which they can use or sell. The production tax credit, or PTC, provides utilities and power producers using renewable energy equipment with a similar credit based on the electricity produced by the clean energy project. These policies have been instrumental in creating demand for the products of a low-carbon industrial base.

The weakness in global capital markets from the financial downturn, however, led to a temporary decline in market appetite for tax credits in recent years. This happened because the recession reduced many companies' earnings and thus reduced their tax appetite, rendering a tax credit useless. Section 1603 of the American Recovery and Reinvestment Act of 2009 provided a stimulus to renewable energy project investment by temporarily creating a grant program, based in the U.S. Treasury Department, which converted these tax credits into refundable grants—effectively bridging this gap in the capital markets. We address the importance of this measure on page 27. This measure has been extended for an additional year.

To create the long-term certainty needed for companies to make investments in innovation, however, demand-driving policies such as the investment tax credit and the production tax credit need to be strengthened and extended for 5 to 10 years, and insulated from annual appropriations processes to minimize investor uncertainty. Even more aggressively, the government could consider granting an outright capital gains tax holiday to investments backing renewable energy projects. As with many innovation-related policy incentives, these measures need predictable sunset paths rather than abrupt or arbitrary end dates.

Driving demand with CLEAN contracts

Another policy tool that can foster predictable strong demand, and increase market transparency for investors, is the creation of so-called CLEAN contracts, otherwise known as feed-in tariffs. These are national, state, or local policies that allow renewable energy project owners to sell their electricity to utilities at a pre-determined, fixed price for a long period of time.

A recent CAP report, "CLEAN Contracts: Making Clean Local Energy Accessible Now," notes that CLEAN contracts:

> *... are far and away the most important market creator for renewable energy in the world. Globally, the U.S. Department of Energy's National Renewable Energy Lab has found that 45 percent of all wind energy and 75 percent of all solar photovoltaic, or PV, electricity capacity installed before 2008 was directly linked to this tool.*[118]

Congress and the president should take a look at the success of this strategy abroad and in a handful of U.S. states and regions. The paper also recommends that state and local activists and legislators consider the following strategies for immediate action to promote CLEAN contracts:

- Implement a CLEAN program at a municipal or cooperative utility.
- Engage with the Federal Energy Regulatory Commission to clarify how they would view potential statewide CLEAN contracts.
- Encourage federal lawmakers to sponsor and vote for legislation that would amend federal law to allow states to implement CLEAN programs.
- Build a base for CLEAN supporters in a state so that state legislators can move forward as the regulatory environment becomes clearer.

Use standards to send clear market signals for low-carbon products and technologies

While U.S. political debates frequently cast "regulation" as a synonym for burdensome government intrusion in private markets, smart federal standards paired with targeted incentives can actually be highly effective at jumpstarting the growth of new markets and industry segments. Smart standards can help activate new demand, increase scale, and drive down costs for low-carbon energy, vehicles, equipment, building systems, and other goods.

In our 2009 Clean Energy Investment Agenda, CAP outlined how these kinds of policies can help create market demand for clean energy goods and services. CAP helped develop and advocated for Congress to pass the HOME STAR bill to set standards and create investment incentives for energy efficiency in small residential buildings, as well as Building Star to do the same in commercial buildings.[119] Both bills passed in the House in 2010 but were stalled in the Senate.

More recently, CAP has been involved in the Better Building Initiative, a White House proposal to reduce commercial-building energy use by 20 percent by 2020. These provisions would pair strong incentives for commercial-building energy efficiency with market-based incentives for commercial building owners to invest in building retrofits and technology to reduce end-use demand for energy. This program could save businesses $40 million a year, create demand for new energy-efficiency building equipment, and create high-quality construction and manufacturing jobs.

Low-carbon innovation in home appliances and consumer goods can help make our economy more energy efficient.

Low-carbon innovation in home appliances and consumer goods also can help make our economy more energy efficient. The Environmental Protection Agency needs to continue its review of the Energy Star program to improve enforcement and verification and ensure the label retains its rightful place as an honor to strive for, rather than a hoop through which all appliance makers can easily jump. Energy Star as a voluntary program has shown the value of high performance standards for product differentiation and as a tool for increasing consumer choice and brand recognition for low-carbon technologies.

Another report by CAP and the National Resources Defense Council, "Driving Growth," shows how enhanced Corporate Average Fuel Economy, or CAFE, standards for the U.S. automotive fleet are helping create tens of thousands of jobs and create opportunities for industrial formation and job growth in vehicle efficiency technologies and components.[120] Current CAFE standards will require car manufacturers to achieve an average of 34.1 miles per gallon across all the passenger cars and light trucks they sell starting in model year 2016, expanding the market for more fuel-efficient cars.

From renewable energy standards to set predictable growth trajectories and investment pathways for the utility industry, to strong national energy-efficiency standards and building codes that lay out design requirements and standards for appliances and building materials, smart policy can have a tremendous impact in

ensuring the market for American-manufactured clean energy products is transparent, predictable, and long lived. Ensuring strong demand pull is essential for the broader suite of supply-side financial, tax, and research measures to have a lasting impact in the growth of markets. In addition to these core elements of market innovation, a low-carbon industrial strategy for the nation should also address a number of broader issues that are fundamental to our industrial competitiveness. We now turn to this larger context.

Investing in the building blocks of innovation

In addition to the targeted policies designed to engage with specific participants in American low-carbon industries and innovation networks, there are certain needs shared by all participants in these markets that must be addressed.

Earlier periods of American growth and innovation took place in an environment of robust investment in infrastructure and education. These massive investments served as the fertile soil from which America reaped the harvest of its growing competitiveness. To drive economic recovery and revitalize industrial growth, we must begin again to invest in replenishing the fertility of this soil that nourishes the roots of American entrepreneurial innovation.

We must do so through the construction of state-of-the-art transportation infrastructure such as high-speed rails and modern ports, smart electric grids that use more information to reduce demand for energy, and educational infrastructure from kindergarten-through-12th-grade education that cultivates critical science, technology, engineering, and math skills that enable higher learning at the post-secondary levels of education. Making these improvements will allow the United States to stay innovative and competitive with countries that now are racing ahead.

The United States has an impressive network of existing infrastructure, from deep water ports to the world's original transcontinental rail system, and from national laboratories to top-notch research universities. But some sectors of existing infrastructure, such as the national power grid, our highways and railroads, our K-12 education system that graduates only two-thirds of its students, and our workforce training system, are suffering from years of underinvestment, and as such are holding the country back from its potential to innovate and compete at the highest levels.[121]

This presents a challenge to all industries, particularly to the clean-technology and low-carbon sectors. It also represents an opportunity to refocus on the challenge of jumpstarting both public and private investment in renewed infrastructure and industrial transformation. As the president said in his weekly address on January 29:

[Innovation] starts by making sure that every single child can get a good education, and every American can get college or career training. Because that's what will help light the spark in the minds of innovators, and ensure that our people have the skills to work for innovative companies. We also need to make sure that America can move goods and information as fast as any of our competitors, whether on the road, or online. Because good infrastructure helps our businesses sell their products and services faster and cheaper.[122]

By necessity, clean energy will be at the center of this effort. Revitalizing and reinvesting in the nation's electricity infrastructure to make it more energy efficient is essential for American industrial and economic competitiveness, for regional economic development, and for our energy security. Likewise, revamping the national transportation system to focus on low-carbon trains and electric cars presents an immense opportunity for private capital. But in this moment of fiscal austerity, this opportunity will only be realized through effective public-private partnerships, with government strategically helping move private capital investment in ways that meet the needs of the nation.

In his 2011 State of the Union speech, President Obama pledged to provide 80 percent of Americans access to high-speed rail within 25 years. This will be a huge step in the right direction that will open the gates for major private investment. In addition to physical infrastructure, building a clean energy economy also requires an investment in human capital. This means investing in schools from kindergarten to community and technical colleges to four-year universities and beyond, to make our workforce the most innovative, skilled, and creative in the world.

Strengthen primary and secondary STEM education

Any industrial strategy must be informed by the reality that all industries are designed, run by, and improved upon by people. Building new innovation systems to transform our industries for the low-carbon economy will require talented scientists and engineers. Fifty-nine percent of Chinese students major in fields related to science or engineering, as opposed to only 32 percent in the United States. Overall, the United States ranks 27th among developed nations in the proportion of college students receiving undergraduate degrees in science or engineering.[123]

To remedy this disparity, the president has called for adding 10,000 new science, technology, engineering, and math teachers each year, and to strengthen the skills of the 250,000 current STEM teachers by implementing the programs in the

president's Educate to Innovate agenda. This is a forward-thinking program that is leveraging public and private investment into STEM education around the country.

Corporations, fearing they may face a shortage of well-qualified workers in the future, have begun to invest heavily in STEM education, not just for their own workers but even at the K-12 level. As part of the Educate to Innovate campaign, the White House has convened more than 100 major U.S. companies to found a new 501(c)(3) nonprofit called Change the Equation, which is investing more than $700 million in private dollars in overhauling STEM education in the United States.[124] But the fact that companies are putting their own profits into general STEM programs suggests that the government is not doing enough to ensure our children receive adequate instruction in the skills of innovation.

Ensuring our workforce can compete with STEM-trained workers globally will require a renewed focus on teacher training.

Ensuring our workforce can compete with STEM-trained workers globally will require a renewed focus on teacher training. Studies show, unsurprisingly, that students excel in math when their teachers have higher levels of mathematics education knowledge.[125] But as a 2008 report by the National Council on Teacher Quality pointed out, teacher preparation requirements in math and science vary widely from state to state, and 18 states don't have any teacher proficiency requirements pertaining to specific areas of math whatsoever.[126] The report finds that math teachers at the elementary level are often not professionally equipped to teach math, giving their students a slow start in their math learning which can hold them back for years.

To respond to this, the federal government should work with state agencies to set up accountability systems for their teacher training programs, to better assess their effectiveness in preparing students for careers in STEM. In so doing, federal policy could help create common, higher, and clearer standards for STEM teacher certification to help level the playing field for students in every state.

In addition to increasing standards for teacher training program accountability, we need to strengthen and harmonize the licensure requirements for K-12 STEM teachers once they have completed training. It is unacceptable that teachers in many states can become licensed to teach math and science without demonstrating their proficiency in these fields.

Finally, the federal government should invest in programs that create opportunities for college graduates from STEM fields to go into teaching careers by streamlining their licensing and supporting alternative certification programs that build on the skills they learn in college.

Some work is already underway toward these ends. The Obama administration released a blueprint in 2010 detailing how some of these reforms could be incorporated into the reform of the Elementary and Secondary Education Act, which is due for reauthorization.[127] One of these initiatives would include a $300 million competitive grant program to help high-need districts implement evidence-based teacher quality improvement for STEM fields. And the president's FY 2012 budget includes funding for a new agency, the Advanced Research Projects Agency-Education, or ARPA-ED, which:

> *... will aggressively pursue technological breakthroughs that have the potential to transform teaching and learning the way the Internet, GPS, and robotics (all areas where the Defense Advanced Research Projects Agency, or DARPA, has had a profound impact) have transformed commerce, travel, warfare and the way we live our daily lives.*

ARPA-ED will bring together public- and private-sector research and resources to pursue breakthroughs such as digital tutors as effective as personal tutors, courses that improve the more students use them, and educational software as compelling as the best video games.[128]

Help build STEM career pathways and support working learners

Beyond K-12 STEM education, steps to improve college graduation rates and provide alternative paths to skill advancement are also warranted. Only 34 percent of so-called working learners—those who both work and pursue some type of postsecondary education—in college actually complete a degree after six years of study.[129] Creating opportunities for workers to gain new skills while continuing to support themselves and their families is a critical ingredient for success in the 21st century innovation economy. To keep our workforce educated and competitive, we need to build bridges from STEM education programs in elementary and secondary school to postsecondary education at universities, colleges, and especially community colleges.

Community colleges are an under-recognized backbone of our economy. They are places that bring communities together and provide workers with important technical training that can help them advance and excel in the innovation economy. Community colleges are now being heralded as a key component in reviving economic opportunity for workers and national competitiveness for the United States. CAP's 2009 report, "Re-imagining Community Colleges in the

21st Century," outlines important measures we need to take nationally to keep up the rapidly shifting demand for skills in 21st century labor markets.[130]

Beyond community colleges, we also need to make sure workers are supported throughout their careers. Fully funding career One-Stop Centers, which in the past have received wavering support from Congress, would have both immediate and long-term benefits. Career One-Stop Centers were developed in the early 1990s and since have evolved into a national network of service centers designed to bring together employment and training services that work with all people into one place and make it easier for job seekers and employers to use these services.[131]

In the short run, improving these centers would help the 14 million Americans who are currently out of work access unemployment services and new job opportunities. In the longer run, doubling down on this critical workforce development infrastructure and ensuring they focus on STEM and other 21st century skills would have long-run benefits in strengthening career pathways and helping prepare our workforce to compete in the innovation economy. In addition to the Elementary and Secondary Education Act, the Workforce Investment Act of 1998 is also up for reauthorization and could provide an important vehicle for enacting some of these essential workforce reforms.

Reform our immigration policies to remain the land of opportunity

Staying competitive in the innovation economy of the future will require making sure America continues to attract the world's best and brightest minds. Foreign nationals comprise two-thirds of Ph.D. students in the United States and are responsible for founding 50 percent of Silicon Valley startup companies. Yet our immigration laws make it difficult for immigrants to transition from education to work, and to move from job to job in the innovation economy, drastically reducing the ability of these skilled workers to contribute to our economic growth at the level of their potential.

We need to streamline visa processing for international students, make it easier for students graduating with degrees in STEM fields to remain in the United States, make the cap on highly skilled visas more flexible, and create easier paths to permanent residence for highly skilled workers with graduate-level degrees in these fields. We also need to ensure those undocumented immigrants raised in the United States and now in college get the chance to become citizens and contribute to the nation they call home.

Two pieces of legislation addressing some of these issues were introduced in the last Congress (the 111th) and should be brought back up in the 112th Congress. The first is the Development, Relief, and Education for Alien Minors Act, or DREAM Act, which could have added as many as 252,000 new scientists and engineers to America's workforce.[132] The second is the Stopping Trained in America Ph.Ds From Leaving the Economy Act of 2011, or STAPLE Act, which would have created a new class of workforce visas for high-skilled, foreign-born Ph.Ds to stay and work in the United States in the STEM field of which they graduated. Congress should reconsider these pieces of legislation and ensure our immigration policy is aligned with the goals of innovative industries.

Capitalize on regional assets and existing state and local policies

Policymakers at both the regional and federal levels understand that new industries are built from the bottom up, not the top down. Where regions leverage their unique human, physical, and institutional capital and assets, innovation flourishes and industries thrive.

Accordingly, in recent years we have seen the beginnings of reorganization of existing regional industrial and economic development mechanisms to support industrial development around clean energy and other innovation-centric industries. One case in point: the Energy Regional Innovation Cluster, or E-RIC, initiative, which tapped money from seven federal agencies to help kick-start a regional innovation ecosystem and job-creation engine focused on building energy-efficiency systems in the Philadelphia region.[133] (see box)

But this unprecedented program was a one-time event that relied heavily on personal relationships within the current administration, and on specific and time-limited stimulus funding from the American Recovery and Reinvestment Act of 2009. Programs like the E-RIC initiative need to be bigger, the implementation cleaner, and the programs funded need to be better insulated from the uncertainty of annual appropriations.

President Obama has similarly championed this competitive grant model within education policy, called "Race to the Top." The program organizes federal investments that incentivize greater alignment of state and local policies to maximize their public impact. In February the administration expanded this vision by announcing a "Race to the Green" program to promote investment in energy-

efficient building technology, modeled after these innovations in the Department of Education, and we talked on page 37 about the i6 Green Challenge, which similarly pools resources from across the federal government to promote collaboration and competition within and between regions, respectively, to build job-creating, clean energy-focused business plans that capitalize on existing regional assets.

In "Geography of Innovation: The Federal Government and the Growth of Regional Innovation Clusters," CAP's online magazine Science Progress lays out some core principles to guide the interaction of federal innovation and economic development policy with that of states, regions, and localities.[134]

Supporting investments in research, manufacturing, and industrial infrastructure in targeted regions is an effective way to encourage innovation-led economic development.

Grant programs that support simultaneous and coordinated investments in research, manufacturing, and industrial infrastructure in targeted regions are an effective way to encourage innovation-led economic development. By encouraging researchers, producers, investors, and consumers of clean energy technology to come together and share regional assets, these programs help build supply and demand simultaneously to accelerate industrial growth at the regional level. But we need to enhance existing competitive matching-grant and credit-enhancement programs with new criteria to ensure federal funding makes the biggest impact by cultivating local leadership and focusing on priority technology sectors for low-carbon industrial growth, such as clean energy, biotechnology, and advanced manufacturing.

As we discussed on page 37, the president's FY 2012 budget contains a number of programs that together build on these initiatives, including the "Innovation Fund" and "Impact Fund," two new $200 million annual matching funds managed by the Small Business Administration that total $1 billion each over the next five years. These funds are designed to provide one-to-one capital matches to investors navigating the valley of death between innovation and commercialization for clean energy technologies, and for investments in business in underserved communities, respectively.

In addition, the new market tax credits, which provide investors with a tax break for investing in underserved or low-income communities, have had real success in attracting private capital for business formation.[135] Programs like these that address the twin goals of technology innovation and regional economic development should form the basis of our private-sector-led, bottom-up industrial strategy. In these ways, the federal government could convene the most powerful American engines of economic growth—new ideas, entrepreneurs, competitive

businesses, talented workers, and ample capital—to create and commercialize the new clean energy products and services for the 21st century.

Finally, the Department of Energy has issued three out of a planned eight energy innovation hub grants of $122 million for priority clean energy technology research and development.[136] These public-private partnerships bring together all of the types of innovation actors discussed in this paper, along with local, state, and federal policymakers and programs to help accelerate innovation toward broad, congressionally defined technological goals, such as converting sunlight into fuel, modeling advanced nuclear technologies, or designing better buildings with greater energy efficiency. (see box) Congress needs to authorize funding for the next five.

Pay for it by eliminating perverse subsidies and tax loopholes for Big Oil and coal

In the 2011 State of the Union address, the president called for eliminating $4 billion in perverse subsidies for extremely profitable dirty energy companies, and using the savings to fund some of the clean energy investments listed above. But $4 billion is just the tip of the iceberg.

Philadelphia's energy-efficiency innovation cluster

In August 2010 Pennsylvania State University was chosen to serve as the hub of a new model for regionally based technology innovation and economic development. The Energy Regional Innovation Cluster, or E-RIC, program was an interagency program to accelerate innovation and commercialization of building energy efficiency technologies.

The winning consortium, which goes by the name Greater Philadelphia Innovation Cluster, or GPIC, was selected among many applicants to win $129 million in grants and programmatic support from the Department of Energy and six other federal agencies for investment in energy-efficiency technology innovation and commercialization.[137] It was selected because of the opportunity to leverage a unique and diverse set of regional assets including 11 academic institutions, two DOE laboratories, five high-profile industry partners, and federal and regional economic development agencies. Not all members of the consortium are local. Some are multinational corporations such as IBM Corp., or are located as far away as Lawrence Livermore National Lab in California.

Ultimately, this basket of grants helps bring together many of the public and private stakeholders discussed in this report to kick-start the creation of a new industry cluster that will be a boon to the region's economy, create new jobs, attract talent and investment from across the country, and provide worker training opportunities and new skill ladders. This first foray into federally funded, regionally implemented low-carbon industry cluster formation will be an invaluable case study as the federal government works to catalyze the growth of strong clean energy markets in communities around the country, by aligning its assets and investments through the formation of low-carbon innovation networks and partnership projects.

By going beyond direct spending and also eliminating perverse tax incentives including exemptions from deductibility restrictions, the percentage depletion allowance, and others, we could save as much as $45 billion in the next decade.[138] These are special tax loopholes created decades ago specifically to aid the development of the fossil-fuel industry. They have outlived their usefulness in the 21st century and need to be eliminated.

Sen. Jeff Merkley (D-OR) introduced a bill to do just that, but the bill failed to get traction in the 111th Congress.[139] The 112th Congress with its split of Democratic and Republican control could be a perfect opportunity to advance an agenda of energy tax reform that will reduce government waste while leveling the playing field for emerging technology and business innovation.

Given the currently constrained fiscal climate and rancorous budget debates, it is essential to recognize that many of the provisions in this industrial strategy would involve better aligning current investment streams to achieve greater impact, rather than relying on new total investments. Many of the other provisions that do involve direct investments rely on tools like credit enhancements or loan guarantees to leverage far greater private investments that will yield new economic activity, expanded hiring, and better competitive positioning in the global economy. These provisions represent positive investments that yield significant long-term returns in the form of a more prosperous, productive, and efficient economy.

Lastly, in looking for mechanisms to fund these investments, in addition to subsidy shifting and the gradual elimination of subsidies across a range of technologies, it seems likely that the United States will need to turn again in coming years to development of working markets for global warming pollution. Establishing such markets and a price on harmful pollution will not only level the playing field for clean energy but it will also generate the investment capital that America will require to retool, reinvest, and recommit to the success of our economy in a changing global landscape.

Conclusion

As President Obama said in his 2011 State of the Union address, "our free enterprise system is what drives innovation."[140] Government policy and incentives will play an important role in generating conditions for free markets and entrepreneurs to innovate and profit, and ultimately to lead the low-carbon industrial revolution. This will require policymakers to rethink not only how they engage with businesses but also how policies encourage businesses and other market actors to engage with each other. A strategy that promotes collaboration will generate more efficient business planning across the economy that ultimately fosters more profitable and competitive clean energy jobs and industries in the United States.

In the table below, we summarize our policy suggestions, linking them broadly to the market actors they affect. While the policies we recommend are neither complete nor comprehensive, the basic point is indispensible: The success of a low-carbon industrial strategy requires engaging all relevant actors. By unlocking what President Obama called the "synergies" that exist when researchers, manufacturers, investors, consumers, and regulators work together toward common goals, the nation can maximize the benefits and minimize any costs of the coming industrial transition as we retool to respond to the new realities of global warming and a competitive environment shaped by low-carbon energy.[141]

The policies underlying this low-carbon industrial strategy are animated by three overarching purposes:

- 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.

These policies will help in delivering on these three clear national priorities to build domestic markets for low-carbon products and services served by innovative manufacturing businesses in the United States and the skills of American workers. In review, the key policies outlined in this paper are as follows.

American traditions of federalism, state energy regulation, and locally based, entrepreneurially driven economic development require fresh thinking. American entrepreneurs, manufacturers, and investors depend on the development of a coherent set of strategies for low-carbon industrial growth and innovation. This will require a blend of well-coordinated and collaborative federal and state policies and bottom-up, private-sector-led innovation. A U.S. low-carbon industrial strategy can build on policies in numerous fields from innovation, to tax policy, to regulatory reform, to education, workforce training, and economic development, all operating at multiple levels of government.

The challenge before the United States today is to marshal the political will and full national commitment to unite these disparate building blocks into a cohesive strategy. Doing so will capture the opportunity before us to create jobs and growth, improve competitive positioning through innovation, and improve our economic and energy security while reducing climate risks. The consequences of inaction are great. Yet the emerging low-carbon industrial strategies outlined in this paper have the potential to attract the necessary deep support across ideological and regional divides within the American electorate to seize this opportunity and make our economy stronger and more resilient.

America excels at innovation, in no small part because we have spent centuries building a strong foundation for this leadership: our infrastructure, the skills of our workers, vibrant democratic institutions, a top-notch educational system, and a history of embracing the talents and ideas of all the world's people within the American melting pot. We must not take this global leadership for granted or rest on our laurels. Today America must embrace a new set of low-carbon industrial strategies that reinvest in this foundation, if we are to sustain jobs and growth, innovation and competitiveness, and long-term economic security in the United States into the future.

In this "Sputnik moment" we face a challenge. It's time to mobilize the resources needed to meet the demands of a changing global environment, and to build a more dynamic, prosperous, and competitive economy, beginning with low-carbon industrial strategies that ensure American sustained leadership in innovation.

Summary of recommendations

Industrial stakeholders	Key policies
Policymakers and regulators	• Conduct a national industrial competitiveness assessment. (p. 17) • Ensure federal policies integrate with state and local initiatives. (p. 19)
Researchers	• Reform the Patent and Trademark Office to make it more efficient. (p. 22) • Strengthen and simplify the federal R&D tax credit. (p. 22) • Leverage our defense industrial base and research infrastructure for clean energy. (p. 24)
Manufacturers	• Conduct a comprehensive clean energy manufacturing assessment. (p. 27) • Reestablish and expand the clean energy manufacturing tax credit. (p. 28) • Create revolving loans to help manufacturers invest in efficiency and clean energy. (p. 30) • Double down on the Manufacturing Extension Partnership. (p. 31) • Rewire Export-Import Bank to achieve strategic clean energy export goals. (p. 32)
Investors	• Establish a Green Bank to unlock private investment. (p. 34) • Accelerate investment in deployment with Energy Independence Trust. (p. 35) • Retool existing small-business grant programs to focus on innovation. (p. 37) • Level the tax incentives playing field. (p. 38)
Consumers	• Create a national market for carbon pollution by requiring polluters to bear the true costs. (p. 41) • Signal market demand through renewable energy and efficiency standards. (p. 42) • Use the tax code to reduce clean energy costs and increase capital availability. (p. 43) • Drive demand with CLEAN contracts. (p. 45) • Use standards to send clear market signals for low-carbon products and technologies. (p. 45)

Investing in innovation building blocks

- Strengthen STEM education and workforce training. (p. 49)
- Reform immigration policies to remain the land of opportunity. (p. 52)
- Capitalize on regional assets and existing state and local policies. (p. 53)
- Pay for it by eliminating perverse subsidies and tax loopholes for Big Oil and coal. (p. 55)

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Acknowledgements

The authors would like to express their deep gratitude for Andrew Light and Andrew Pendleton for their leadership in sustaining the critically important experiment in international collaboration to advance the debate on climate solutions within the Global Climate Network. We would also like to thank Ed Paisley, Kate Gordon, Richard Caperton, Elaine Diana Epstein, and Raegen Miller for their very substantial contributions of ideas, content, and critical review as we crafted this paper. We would also like to thank the entire CAP editorial and art teams for their high standards, hard work, good humor, and professionalism.

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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.

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