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ISSUE BRIEF

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CLEAN TECH'S RISE, PART I: Will the U.S. and China Reap the Mutual Benefits?

KEY POINTS

- By 2020, the global clean energy market will double or even triple to between $1.4 and $2.2 trillion annually according to some estimates, as the U.S., China, and other countries drive to achieve energy security, economic, and environmental goals.
- In differing respects, the U.S. and China are both leaders in clean energy and have a long history of both competition and cooperation.
- American business is engaged with China across a wide range of low-carbon products and services, generating growth and employment benefits in the United States.
- Successful U.S. action on clean technology requires understanding of a complex reality: The two countries are interdependent in their progress on clean technology. Although lagging in some respects, each excels in other respects.
- Although trade and other frictions are normal, progress is also possible.
- Reaping the opportunities in the burgeoning clean tech market through both cooperation and strengthened competitiveness requires countries to develop supportive policies at home as part of a larger strategy. With such an approach the U.S. can steer its engagement with China on clean tech to benefit both businesses and workers at home, and the world as a whole.

BIG OPPORTUNITIES

Ready or not, the global clean energy revolution is underway.

World-wide, in 2010 alone investors pumped $243 billion[1] into clean power technologies, from wind farms and "smart" transmission grids in the United States and China, to rooftop solar panels and small hydropower generators in Europe and Africa. That's up one-third from the year before, and nearly five times the total in 2004. Expanding the definition past energy generation, to include all low-carbon technologies such as energy efficient buildings and lighting, put the figure at $720 billion annually in 2009.[2] Overall, more than $1 trillion in revenue has flowed to clean energy companies large and small over the last seven years[3]—and despite continuing economic struggles, "the clean energy sector appears to be poised for further strong growth," concluded a recent analysis by the Geneva-based World Economic Forum.[4] By 2020, some analysts forecast that the size of the global clean energy market will double or even triple, to between $1.4 and $2.2 trillion annually.[5] The U.S., China, and countries across the globe are investing in clean energy to achieve energy security, economic and environmental goals, with grid parity between alternative energy and conventional fossil fuels on the near horizon in many circumstances.[6]

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Simple sound bites, complex realities, real benefits

For businesses in the United States, this emerging market offers extraordinary opportunities—and challenges. And nowhere, perhaps, are these more apparent than in the emerging relationship between the United States and China—the world's two largest consumers and producers of energy, and the two leading emitters of greenhouse gases. Although commentators often portray the U.S.-China relationship on clean energy in terms of "leader and laggard," or "winner and loser," the reality is far more complex. The two nations have a lengthy history of both cooperation and competition on clean energy technologies, and "the relationship between the nations defies simplistic assumptions defined by economic nationalism," notes Ethan Zindler, who analyzes clean energy markets for Bloomberg New Energy Finance in Washington, D.C.[7] Chinese solar companies, for instance, have U.S.-made equipment on their factory floors, while wind turbines erected in North Dakota can include parts made in China. Chinese investors are supplying critical capital to U.S. companies even as U.S. experts help Chinese companies structure complex innovation partnerships. Companies from both nations, meanwhile, compete to provide clean energy goods and services to growing markets in Asia, Europe, South America and the Middle East.[8]

China itself, meanwhile, is becoming a critical market. In recent years, it has become the world's largest source of, and destination for, investment in clean energy.[9] China is expected to invest at least $300 billion in domestic clean energy technologies over the next five years[10] as part of its drive to curb greenhouse gas emissions, gain economic benefits, and improve energy security, in pursuit of aggressive renewable energy deployment targets in its 12th Five-Year Plan[11] (see table). "There is no doubt that the country remains committed to the ongoing development of its renewable energy sector," notes a recent analysis from Ernst & Young.[12] The investment race, meanwhile, is heating up. In 2010, China invested a world-leading $45 billion in clean energy, while the U.S. slipped to second place with about $33.7 billion. In 2011, however, the U.S. recaptured the lead, with investment surging to $48 billion, while China invested $45.5 billion.[13]

China's clear commitment to clean energy has made it "attractive to U.S. and international investors" because it offers "the certainty they are looking for before investing," notes Deborah Seligsohn, a China specialist with the World Resources Institute and WRI's ChinaFAQs project. Companies including First Solar, GE, Duke Energy, American Electric Power, and many other U.S. firms have all invested or expressed interest in investing in China, and "increasingly entrepreneurs with new ideas are looking to China to make those ideas become a reality."[15]

GOALS OF CHINA'S 12TH FIVE YEAR PLAN[14]

RENEWABLES (GW total installed capacity)	**2016**
Hydro	260
Wind	100
Solar	15
Bio-energy	13
AIR AND WATER QUALITY	**Reduction by 2016**
Sulfur Dioxide (SO_2)	8%
Chemical Oxygen Demand	8%
Nitrogen Oxides (NO_x)	10%
Ammonia Nitrogen	10%
CLIMATE	**Goals by 2016**
Carbon Intensity	17% reduction
Energy Intensity	16% reduction
Domestic Forest Cover	1.25 million hectare increase 600 mill. m^3 stock volume increase
Non-fossil share of primary energy	11.4%

BUSINESS REAPING THE BENEFITS

Many U.S. companies are already engaged in the Chinese clean energy market. General Electric Company signed five agreements with Chinese partners over the past year, four of which target clean energy and mass transportation. GE expects the agreements to generate more than $2 billion in revenue for the company, with nearly $1 billion in exports from the U.S., and to create or support jobs in both countries, with nearly 4,500 jobs in the U.S. In one agreement, GE and Shenhua Group Corporation plan to develop cleaner coal gasification technologies in China, which is expected to create and support hundreds of jobs in Texas, South Carolina, and New York. Another agreement to develop distributed energy combined heat and power projects jointly with China Huadian Corporation will support over 2,100 jobs throughout GE's domestic U.S. supply chain.[16]

Dr. S. Julio Friedman at Lawrence Livermore National Laboratory points out that other U.S. businesses are collaborating with Chinese partners to develop and deploy renewable energy technology, creating green jobs in the United States. Friedman says "thanks to Chinese partnerships with GE, Applied Materials, Duke Energy, and others, those companies have been able to build plants, hire people, demonstrate technology, and underwrite projects." EmberClear (formerly FutureFuels),[17] an energy company in Pennsylvania, is using technology developed and tested by Chinese energy company Huaneng, to build an advanced coal power plant in Pennsylvania, creating thousands of jobs there.[18] IBM is investing in efforts to supply its customer China State Grid Corporation for smart grid infrastructure buildout with digital sensors and communication networks.[19] GE, Duke Energy, Powerspan, Peabody, and others have partnered with Chinese firms to develop and demonstrate carbon capture and storage technologies. Friedman notes that "these relationships are a pathway for advancing the technologies and lowering their costs."[20] Chinese wind firm Goldwind chose LM Windpower's manufacturing plant in North Dakota and other Midwestern manufacturers of wind energy components to supply construction of a 110 megawatt wind farm in Illinois.[21]

The result of these partnerships is that, in addition to jobs, the U.S. will benefit from lower-cost, tried and tested technologies, global climate will benefit from reduced emissions, and businesses will benefit from growing trust between partners in both countries, paving the way for future collaborations.[22]

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>
> **— S. JULIO FRIEDMAN, LAWRENCE LIVERMORE NATIONAL LABORATORY**

EXAMPLE: SECOND WIND[23]

In the fall of 2010, a team of engineers carefully installed an unusual, six-foot high enclosure on a windy plain some 200 miles northwest of Beijing. Inside the gray casing—which looks a bit like a giant rabbit from some angles—is a sensitive device that uses sound waves to measure wind speeds hundreds of feet up into the sky. It's called the Triton Sonic Wind Profiler, and the American-made technology helps wind farm developers identify the best, most cost-effective spots to build their power plants. The Triton is also just one example of how U.S.-China cooperation on developing better and cheaper renewable energy technologies is helping U.S. firms gain a foothold in the growing Chinese energy market, and helping China curb its emissions of greenhouse gases.

A little-known program called the U.S.-China Renewable Energy Partnership (USCREP) "helped us make the right connections that led to this first key installation," says Larry Letteney, CEO of Second Wind Inc., a 31-year-old company that makes the Triton at its manufacturing plant near Boston, Massachusetts.

Value Proposition— Such match-making is part of USCREP's "value proposition," says David Kline, an energy specialist at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) in Golden, Colorado, which manages USCREP. "The U.S. has strong interests in China," he notes, ranging from fostering fair, transparent trading practices to solving energy and environmental problems that confront both nations and the world at large. As the world's two major emitters of greenhouse gases, for example, both nations have an interest in advancing technologies, such as wind power, that can reduce reliance on burning fossil fuels.

Wind Power Rising— The potential benefit of collaboration between the United States and China isn't lost on wind industry executives in both nations. China has been doubling its wind capacity annually in recent years, and building new wind farms is a key part of China's strategy to boost the amount of power it gets from non-fossil fuel sources. "There is serious discussion of and planning for producing 150 to 300 new gigawatts of wind and solar power in China by 2030," notes Kline.

As a result, "any company that expects to be a serious player in the international wind power market needs a substantial presence in China," says Second Wind's Letteney. For U.S. companies, China offers a potentially vast market – and an unusual opportunity to rapidly deploy, test and improve new technologies. For Chinese firms, partnering presents an opportunity to accelerate expansion by working with U.S. companies that pioneered ways of converting breezes into kilowatts, and now have decades of experience.

EXAMPLE: SECOND WIND (CONTINUED)

In October, 2010, Second Wind, in partnership with Beijing New Energy Technology Co., exhibited a Triton at a leading wind power conference in Beijing. Soon after, the device was on its way to a HydroChina wind power site near Zhangbei for a months-long performance test.

The results were promising, Letteney says, and the Triton is now poised to become more common at Chinese wind installations. "We're very excited to begin selling into China," he says, noting Triton sales in other nations have already helped add 25 jobs to the company's workforce. The forum for collaboration created by USCREP "was vital in making this happen," he says. "Cooperation was key."

OPPORTUNITIES & CHALLENGES

With the prospect of a $2.2 trillion annual global market for clean energy by 2020, both the U.S. and China taking action on clean energy, and U.S. companies heavily engaged, it is important to understand the relationship between the efforts of the U.S. and China, and the opportunities and challenges ahead.

Interdependence and Tough Competition – Are We Ready?

Experts say that China and the U.S. won't be able to meet their energy and climate goals on their own: "In this area, as in so many others, China and the U.S. are mutually dependent," Ethan Zindler, of Bloomberg New Energy Finance, noted in 2011 testimony before a U.S. Senate committee. "Each must rely at least in part on the other to achieve its clean energy and carbon reduction objectives."[24] If the two countries can successfully collaborate, "the world stands a far greater chance of reducing the threat of global climate change," says Mark D. Levine, a senior scientist at the U.S. Department of Energy's Lawrence Berkeley National Laboratory who has been involved in U.S.-China energy partnerships for decades. "If we do not, it's difficult to see how China will do it all alone."[25]

Both nations have a mutual interest in improving clean energy technologies and driving down prices. Cheaper, better technologies help spur the deployment of clean energy in both nations and create jobs – and not just in manufacturing. For instance, manufacturing photovoltaic panels capable of producing one megawatt of electricity creates about five jobs, Zindler estimates. But installing those panels on residential rooftops creates about ten jobs, highlighting the "significant employment opportunities at the final stages of the value chain" in clean energy.[26]

In short, as the clean energy revolution unfolds, benefits are accruing not just to nations that can competitively manufacture new technologies, but to those committed to developing and deploying them. There are jobs—and profits—to be had at every step of the global supply chain. Equally important, there are environmental benefits to be gained by the world as a whole.

That's not to say reaping those benefits will be easy. Along with similar aims, the United States and China have real differences on trade and other issues that will need to be bridged. And the 2011 bankruptcies of U.S. solar companies and growing pains in China's clean energy industries, such as overcapacity, are reminders of the challenges.

Still, for the United States, the message is clear: when it comes to China, both savvy collaboration and healthy competition will be essential to achieving shared energy and climate goals. At the same time, a shift in strong policy commitments at home to less polluting energy sources will be essential to preparing U.S. businesses to benefit from collaboration and compete more effectively abroad. In particular, the U.S. will need to enact policies that encourage clean energy innovation by creating clear market signals for alternatives to fossil fuels, provide robust resources for basic research into breakthrough technologies—such as microbes that can bring down the cost of biofuels or sensors that can improve energy use—and help students and workers gain the skills necessary to compete in the green energy economy.[27] Through its technological prowess, the United States helped create the clean energy revolution; now the question is whether it will take the steps necessary to reap the greatest benefits.

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— ETHAN ZINDLER, BLOOMBERG NEW ENERGY FINANCE

Understanding the American Advantage

Some U.S. observers worry about competition, and have difficulty seeing opportunity in the U.S.-China relationship. In the wake of the 2011 bankruptcy of Solyndra, a U.S.-subsidized manufacturer of a novel solar PV technology,[28] and amid industry legal action charging that China has unfairly subsidized its solar industry, some observers are asking how U.S. clean energy businesses can compete with Chinese manufacturers. Regardless of how the case turns out, experts say the answer rests in understanding the underlying fundamentals – including the complementary strengths of each nation, and China's place in the global value chain.

In the solar arena, it is true that Chinese companies now dominate solar photovoltaic (PV) module manufacturing, notes Joanna Lewis, a professor at Georgetown University in Washington, D.C. who studies U.S.-China relations on clean energy. "But that does not mean the U.S. is not still playing an important role in the solar industry," she notes. "If we just look at how many solar panels are being manufactured here, we miss the more important metric—the total value created by the solar industry in the United States. A significant portion of the revenue from solar projects comes not from manufacturing the panels themselves, but site preparation and system installation, which must be done locally with local jobs."[29] While manufacturing a solar panel might create a single job in China, for instance, installing that panel in the U.S. can create two jobs, other analysts have found.[30]

In addition, despite perceptions that the U.S. is "losing" the solar power competition, it is in fact a net exporter in the solar industry: In 2010, the U.S. solar industry exported almost $2 billion worth of solar energy products, more than the value of the Chinese panels it imported. The U.S.'s largest export is polysilicon (the feedstock for making crystalline silicon PV cells); the second largest was the capital equipment used to manufacture solar PV products. And although the U.S. had a $278.3 billion trade deficit with China overall in 2010, it had a positive trade balance with China in the solar industry.[31]

This means that "one of the lowest value segments of the solar PV supply chain is made in China, not to mention one of the most energy-intensive," says Lewis. In addition, "China is paying a significant environmental cost" for its solar prowess. Because China has, in the past, exported most of its solar panels, it has gotten little benefit from the emission-free electricity the technology provides."

"Edward Steinfeld, professor at MIT writes that even as Chinese companies assemble products for export to the U.S. and other Western nations, the most valuable components for those products still come from outside China."

Now, new Chinese policies—such as changing how solar electricity producers are paid for feeding their power into national grids—are changing this dynamic and encouraging the deployment of solar energy within China. In part, the moves are driven by government efforts to meet ambitious solar power goals, which have grown from installing 1.6 gigawatts by 2020 to a 50-gigawatt goal. "The price drop in global PV module costs is likely one reason for the change of heart among Chinese policy makers," Lewis says, "in addition to their wanting to see China reap the environmental benefits of the solar technology, and not just the costs."

Given such trends, the 2011 bankruptcies of Solyndra and other U.S. PV companies "should not scare the U.S. away from investing in R&D for innovative solar technologies," she concludes. Rather, U.S. companies need to continue to innovate. "U.S. companies can still compete in advanced solar technologies," she says. "These technologies are high risk but potentially high reward. It is comparatively easy for countries like China to import the polysilicon feedstock and the capital equipment (production line machinery) for solar module manufacturing, but harder to import the technological know-how to enable innovation in this sector. The United States should focus more on the strategic expansion of our own solar industry through innovation in advanced technologies and by creating a domestic environment that supports the use of solar energy, instead of fighting trade wars with China."[32]

U.S. companies also need to keep larger global trends in mind, says Edward S. Steinfeld, a professor at the Massachusetts Institute of Technology and Director of the MIT-China Program. "China is playing our game," he argues in a recent book, *Playing Our Game: Why China's Rise Doesn't Threaten the West*. As China pursues modernization, it has begun to abide by foreign legal and regulatory regimes – which will only help U.S. companies seeking a level playing field. In addition, even as Chinese companies assemble products for export to the U.S. and other Western nations,

the most valuable components for those products still come from outside China. That helps explain why, for instance, the United States' share of global manufacturing by value has actually increased since 1990, he notes.[33]

In the clean energy sector, such market-driven collaboration has clear benefits for both nations, other analysts argue. Indeed, the U.S. and China are "joined at the hip" when it comes to clean energy, concluded a 2010 analysis by Bloomberg New Energy Finance.[34] "The two nations may be in competition, but the big win for both of them would be to drive the cost of a clean power generation below the cost of fossil fuels," says Michael Liebreich, the group's chief executive.

Understanding the Challenges

Like all close relationships, however, this one is bound to include some turbulence.[35] Both countries, for example, "have imposed, or threatened to impose protectionist measures," notes the Bloomberg analysis. China first imposed, and then backed away from "domestic content requirements" in wind turbines, for example. Elements of U.S. industry have accused China of improperly subsidizing its solar industry. "Such protectionism could deny market opportunities and has the potential to drive up clean generation costs in both countries," the Bloomberg analysis notes. So far, however, such disputes have been worked out within bilateral and multilateral fora—a good sign that neither nation is interested in a full-fledged clean energy trade war.[36] In yet another good sign, the countries agreed to work toward reducing tariffs on green goods at a recent Asia-Pacific Economic Cooperation (APEC) summit.[37] Both governments have also backed an array of collaborative research programs, many of which involve companies from both nations (see ChinaFAQs Issue Brief — "Clean Tech's Rise, Part II: U.S.-China Collaboration in Clean Tech Public-Private Partnerships"). These public-private partnerships suggest both sides recognize they can learn from the other —and may have complementary strengths.

Concern among some Western companies remains about China's commitment to protecting intellectual property (IP). Lawsuits alleging IP theft do arise and are watched closely by industry players as they play out. It is important to note that enforcing IP laws is in the interest of the Chinese government, as rebalancing the Chinese economy away from manufacturing and toward research and innovation is a central goal of the 12th Five-Year Plan.[38] But looking at overall trends, research by Professor Edward Steinfeld and colleagues at MIT found that in recent years "these concerns, though still present, have receded somewhat for global technology leaders operating in China."[39]

Many IP concerns may be "solvable problems" that needn't get in the way of cooperation.[40] "We have seen business members eager to work with Chinese partners, because they believe there is information and opportunity that can flow in both directions," says Deborah Seligsohn of WRI's ChinaFAQs.[41] China's booming energy sector, for example, offers opportunities to test and develop new technologies that might not find a testbed elsewhere. The U.S.-China Clean Energy Research Center, for example, late in 2011 developed a series of innovative intellectual property agreements that have opened the way to closer collaboration.[42]

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> **— KELLY SIMS GALLAGHER, TUFTS UNIVERSITY**

THINKING STRATEGICALLY ABOUT THE U.S., CHINA, AND CLEAN ENERGY

There are big opportunities available, but to take advantage of these opportunities, the U.S. needs to build on its strengths. Clean energy is close to being cost competitive with conventional fossil fuels,[43] and policies can make a difference.[44] Indeed, benefits occur where there are supportive policies.[45]

In the U.S., the Congress and the Executive Branch have sent mixed signals to the domestic clean energy industry, extending and then withdrawing supportive policies, sowing uncertainty. However, "in order for the United States to remain competitive in clean energy," writes Kelly Sims Gallagher, Professor of Energy and Environmental Policy at Tufts University, it needs to strengthen its energy innovation system and ensure a level playing field for its firms with "practical energy policies that are stable, credible, aligned, and consistent to realize the deep and currently unrivaled

potential of the U.S. energy innovation system." A supportive policy environment for clean energy innovation is "likely to catalyze the creation of new firms, strengthen others, generate new jobs, capture growing markets, improve energy security, and address important environmental challenges, as they have in other countries."[47]

When it comes to China, U.S. policy makers will need to think strategically both about specific policies and overall strategy—indeed, the answers to many problems are to be found here at home.

While many of the specific measures set forth on the following pages are desirable, it is important to consider how they fit into a broader strategy based on an understanding of the components of the innovation and deployment process. Experts describe four elements of this process: creating markets for low-carbon power, financing companies and projects, creating new knowledge, and providing clear regulation (see box: Getting Our Act Together on Solar – Elements of a Winning Strategy).

As indicated in the examples on the following pages, public policy can help scale up the market by taking steps to catalyze innovation and demand for clean energy goods and services. We provide examples of proposals and policies for action across a menu of topics which experts and interested officials and stakeholders have suggested deserve attention and action (see appendix for details).[47] Not all of these policy options are available exclusively to the U.S. Some have been employed elsewhere by other nations seeking to improve energy efficiency and climate performance with varying degrees of effectiveness.[48] China, for example, is considering implementing a nationwide cap on energy or coal consumption.[49]

FOUR ELEMENTS OF A STRATEGY FOR THE U.S. SOLAR INDUSTRY: "GETTING OUR ACT TOGETHER ON SOLAR – ELEMENTS OF A WINNING STRATEGY"[50]

In recent years, the global solar market has changed dramatically. As a global oversupply of solar panels developed in 2008, module prices began a slide that continues today, contributing to growth in demand for solar technology. U.S. exports have grown dramatically in absolute terms, but have been dwarfed by the rise of exports from China in recent years. The U.S., however, remains an innovation leader with interests in a wider range of solar technologies than China and maintains a trade surplus when the whole solar value-chain is considered.

For U.S. manufacturers to continue to compete in the global solar market, the U.S. government needs to focus on working with them to boost innovation, particularly in higher-risk technologies that could prove significantly cheaper than the current technology. As Professor Edward Steinfeld of the Massachusetts Institute of Technology points out, in addition to being good at research, we need to actively pursue the later stages of innovation, "demonstrating, scaling, and improving," or we risk losing the knowhow to deploy what we invent.

Creating markets for low-carbon power. Until solar PV technology is competitive with fossil fuel options, mandates or incentives are necessary to support demand. Using public funding to support the market is economically efficient when the social benefits of lower pollution, economic development, and climate change mitigation are included.

Financing companies and projects. Companies with new, innovative technologies require financing for growth and scaling-up that can stomach risk. The unique venture capital community in the U.S. can provide financing to riskier, smaller companies, but the economic crisis and policy gridlock have dampened interest in clean technology. Federal programs like DOE's Advanced Research Projects Agency – Energy (ARPA-E) grants can be powerful tools to support companies, draw in private sector finance, and move ideas from demonstration to commercialization.

Creating new knowledge. The U.S. National Laboratory system is crucial to doing the research that comes before commercial products, but is badly underfunded. The United States invested less than half of what China spent on energy RD&D in 2008, and the FY12 budget proposed by President Obama was significantly lower than recommended by the President's Council of Advisors on Science and Technology to meet America's energy challenges.

Providing clear regulation. Solar projects in some developing countries have run into trouble when a premium is available but rules for deployment are outdated or unclear. U.S. entrepreneurs face a similar challenge with the wide diversity of municipal codes, which raises the risk and thus the cost of new technologies.

Investing in innovation is one of the few strategies to increase competitiveness that can succeed on a limited budget and in tough economic times. In order to reap the most from the transition to low-carbon power and from massive energy infrastructure expansion in emerging economies like India and China, the United States must increase public investment in innovation and develop a stable and clear regulatory environment wherever possible.

Proposals and Policies for Action

- **Putting a Price on Carbon**
  This could entail either a tax on CO_2 emissions or a cap-and-trade system, which could incentivize investment in clean energy technology.[51]

- **Promoting Clean Energy Technology Deployment**

  Clean or Renewable Energy Standards, or policies requiring that a certain percentage of electricity be generated from clean or renewable sources, can reduce risk for businesses and encourage deployment of renewables.

  Incentives such as tax credits for renewable energy producers and consumers, and grants or loan guarantees. These incentives can have a variety of targets, from utilities seeking to build large renewable energy generation installations, to homeowners installing small distributed solar panels or energy efficient windows.

  Access to Funding, either in the form of direct grants or guaranteed loans, can spur research, development and deployment of renewable energy technologies.

- **Efficiency**
  Legislation such as the Energy Savings and Industrial Competitiveness Act of 2011 proposed by Senator Jeanne Shaheen (D-NH) and Senator Rob Portman (R-OH) can seek to define national energy efficiency standards for building codes, appliance standards, and government procurement requirements and operating procedures.

  Industrial Efficiency— As the largest energy consumers in the nation, federal and state governments can also work with industry partners in manufacturing partnerships, upgrade programs, joint R&D and supply chain management.

- **Innovation**
  Encouraging private investment in research and development— Remaining a global leader in clean energy technology, will require continual development and commercialization of new technologies. U.S. businesses have long called for a national energy innovation strategy.[52] A predictable and long-term clean energy policy would help reassure innovators and venture capitalists that their efforts will pay off.[53]

  Federal support for research, development, and deployment— Initiatives such as the Department of Energy's Advanced Research Projects Agency for Energy (ARPA-E) can fill a gap in funding game-changing technologies that may appear too risky for private investors, but with the potential to generate large economic and environmental returns if successful.

- **Federal Executive branch action**
  The Environmental Protection Agency has proposed New Source Performance Standards (NSPS) that would limit emissions from new power plants to no more than 1,000 pounds of carbon dioxide per megawatt of electricity produced. These standards would reinforce trends toward low-carbon energy sources, and give businesses greater certainty about future investments in the energy sector.[54]

  National Vehicle rules— Under the provisions of the Clean Air Act, the Executive branch can tighten national fuel standards to improve fuel economy for road, marine, and airborne vehicles. Proposals for further tightening are pending.[55]

- **State action**
  State governments are pursuing a number of emissions mitigation policies. Some have established renewable energy portfolio standards and emissions reductions targets, utility regulatory policy reforms, low-carbon growth planning, and others.[56]

FUTURE PROSPECTS

China is among the leading countries in clean technology, as noted earlier. What the U.S. does to maintain leadership in clean technology will help it to be competitive and to take advantage of commercial and public-private partnerships[57] with China and other countries.

Strong action on a strategy with initiatives such as those described above would serve both economic and environmental goals – and help build a foundation for a constructive relationship between the United States and China. As indicated earlier, the efforts of the two countries are interdependent. Moreover, the opportunity to achieve large economic and environmental benefits exists if both countries take action. With smart and strategic initiatives, the U.S. can steer engagement with China on clean tech to benefit both businesses and workers at home and the world as a whole.

APPENDIX: POLICY RESOURCES

- **PRICE ON CARBON**
  - **Carbon Tax**
    - Richard G. Newell. "Assessing U.S. Climate Policy Options, Issue Brief 9: Climate Technology Research, Development, and Demonstration: Funding Sources, Institutions, and Instruments." Resources for the Future. (2007) Page 118
      "An emissions price established through a GHG cap-and-trade or tax system would induce firms to invest and innovate in developing technologies that reduce emissions more effectively and at lower cost."
    - Resources for the Future and Peterson Institute for International Economics workshop. "Fiscal Reform and Climate Protection: Considering a U.S. Carbon Tax." (October 18, 2011)
      "The fiscal policy debate now underway in Washington could quite likely result in fundamental U.S. federal tax reform. Many economists agree that lowering distortionary taxes (for example, payroll and corporate income taxes) can accelerate economic growth and job creation. Putting a price on carbon dioxide emissions via a carbon tax—and using the resulting revenue to reduce distortionary taxes—has the capacity to both strengthen the economy and protect the global climate."
    - World Resources Institute. "A Green Employment Tax Swap: Using a Carbon Tax to Finance Payroll Tax Relief." (May 2007)
  - **Cap & Trade**
    - World Resources Institute. "Bottom Line on Cap-and-Trade." (July 2008)
      This fact sheet provides answers to some of the basic questions about cap-and-trade programs and reviews how such a system might work in the United States.
    - Federal Action
      - US-Climate Action Partnership. "A Call for Action." (January 2007)
        "The U.S. climate protection program should create a domestic market that will establish a uniform price for GHG emissions for all sectors and should promote the creation of a global market."
    - State and Regional Action
      - World Resources Institute. "Report Finds Regional Greenhouse Gas Initiative (RGGI) Creates Jobs and Stimulates Economic Growth." (November 21, 2011)
        A recent analysis concluded that the Regional Greenhouse Gas Initiative in the Northeastern United States has injected $1.6 billion into the region's economy and created 16,000 jobs, while reducing energy bills by $1.3 billion.
        "California continues to implement its comprehensive statewide climate program, which combines targeted measures to achieve emission reductions in particular sectors with a broad multi-sector GHG cap-and-trade program."
      - World Resources Institute. "With Federal Climate Policy Stuck in Neutral, California Moves Ahead." (November 15, 2011)

- **Four Pollutants**
  - Energy Information Administration. "Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants with Advanced Technology Scenarios." (October 2001)

PROMOTING CLEAN ENERGY

- **Clean/Renewable Energy Standard**
  - World Resources Institute. "Clean Energy Standard Act of 2012 Summary." (March 7, 2012)
  - U.S. Energy Information Administration. "Analysis of Impacts of a Clean Energy Standard as requested by Chairman Bingaman." (November 30, 2011)
  - The White House. "State of the Union Address Clean Energy Standard fact sheet." (January 2011)
  - Environmental Protection Agency. "States with Renewable Portfolio Standards." (May 2009)
- **Incentives (taxes, grants)**
  - Business Council for Sustainable Energy. "650+ Businesses and Trade Groups Urge Extension of Clean Energy Tax Incentives." (March 13, 2012)
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      "We must reinvent our energy future," said Chad Holliday, who serves as AEIC chairman. "A giant leap in energy technology investments and reform of our current system can make America a global leader in what will be the largest new market of the 21st Century. We have seen huge dividends from similar American investments before—in information technology, defense technology, and medical technology. But up until now, energy investments have gotten short shrift. That has to change if we are to control our energy future. This has to be at the top of America's agenda."
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    - President's Council of Advisors on Science and Technology. "Accelerating the Pace of Change in Energy Technologies Through an Integrated Federal Energy Policy." (November 2010) Page 1
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