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Rising Tigers Sleeping Giant

Asian Nations Set to Dominate the Clean Energy Race by Out-Investing the United States

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NOTE: This is an abridged version of this report consisting of excerpted Sections

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Overview

This report provides the first comprehensive comparison of public investments by the United States and key Asian competitors in core clean energy technologies, including solar, wind, and nuclear power, carbon capture and storage, advanced vehicles and batteries, and high-speed rail. Core findings include:

1. **Asia's rising "clean technology tigers" – China, Japan, and South Korea – have already passed the United States in the production of virtually all clean energy technologies, and over the next five years, the government's of these nations will out-invest the United States three-to-one in these sectors.** This **public** investment gap will allow these Asian nations to attract a significant share of **private** sector investments in clean energy technology, estimated to total in the trillions of dollars over the next decade. While some U.S. firms will benefit from the establishment of joint ventures overseas, the jobs, tax revenues, and other benefits of clean tech growth will overwhelmingly accrue to Asia's clean tech tigers.

2. **Large, direct and sustained public investments will solidify the competitive advantage of China, Japan, and South Korea.** Government investments in research and development, clean energy manufacturing capacity, the deployment of clean energy technologies, and the establishment of enabling infrastructure, will allow these Asian nations to capture economies of scale, learning-by-doing, and innovation advantages before the United States, where public investments are smaller, less direct, and less targeted.

3. **Should the investment gap persist, the United States will import the overwhelming majority of clean energy technologies it deploys.** Current U.S. energy and climate policies focus on stimulating domestic demand primarily through indirect demand-side incentives and regulations. Should these policies succeed in creating demand without providing robust support for U.S. clean energy technology manufacturing and innovation, the United States will rely on foreign-manufactured clean technology products. This could jeopardize America's economic recovery and its long-term competitiveness while making it even more difficult to reduce the U.S. trade deficit.

4. **Proposed U.S. climate and energy legislation, as currently formulated, is not yet sufficient to close the clean tech investment gap.** In contrast to more direct investments by Asia's clean tech tigers, current U.S. policies rely overwhelmingly on modest market incentives that are viewed by the private sector as more indirect, create more risks for private market investors, and do less to overcome the many barriers to clean energy adoption. The American Clean Energy and Security Act, passed by the U.S. House of Representative in June 2009, includes too few proactive policy initiatives and allocates relatively little funding to support research and development, commercialization and production of clean energy technologies within the United States. Including investments in clean energy R&D, demonstration, manufacturing and deployment in both U.S. economic recovery packages and the House-passed climate and energy bill, the United States is poised to invest $172 billion over the next five years, which compares to investments of $397 billion in China alone, a more than four-to-one ratio on a per-GDP basis.

5. **If the United States hopes to compete for new clean energy industries it must close the widening gap between government investments in the United States and Asia's clean tech tigers and provide more robust support for U.S. clean tech research and innovation, manufacturing, and domestic market demand.** Small, indirect and uncoordinated incentives are not sufficient to outcompete China, Japan, and South Korea. To regain economic leadership in the global clean energy industry, U.S. energy policy must include large, direct and coordinated investments in clean technology R&D, manufacturing, deployment, and infrastructure.

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Executive Summary

Asia's rising "clean technology tigers"—China, Japan, and South Korea—are poised to out-compete the United States for dominance of clean energy markets* due to their substantially larger government investments to support clean technology research and innovation, manufacturing capacity, and domestic markets, as well as critical related infrastructure. Government investment in each of these Asian nations will do more to reduce investor risk and stimulate business confidence than America's currently proposed climate and energy legislation, which includes too few aggressive policy initiatives and allocates relatively little funding to directly support U.S. clean energy industries. Even if climate and energy legislation passed by the U.S. House of Representatives becomes law, China, Japan and South Korea will out-invest the United States by a margin of three-to-one over the next five years, attracting much if not most of the future private investment in the industry. Global private investment in renewable energy and energy efficient technologies alone is estimated to reach $450 billion annually by 2012 and $600 billion by 2020,[1] and could be much larger if recent market opportunity estimates are realized.[2] For the United States to regain economic leadership in the global clean energy industry, U.S. energy policy must include more significant, direct and coordinated investment in clean energy R&D, manufacturing, deployment, and infrastructure.

Asia's clean tech tigers are already on the cusp of establishing a "first-mover advantage" over the United States in the global clean tech industry. This year China will export the first wind turbines destined for use in an American wind farm, for a project valued at $1.5 billion.[3] With no domestic manufacturers of high-speed rail technology, the United States will rely on companies in Japan or other foreign countries to provide rolling stock for any planned high-speed rail lines. And all three Asian nations lead the United States in the deployment of new nuclear power plants. The United States relies on foreign-owned companies to manufacture the majority of its wind turbines, produces less than 10 percent of the world's solar cells, and is losing ground on hybrid and electric vehicle technology and manufacturing.[4] As this report demonstrates, the United States lags far behind its economic competitors in clean technology manufacturing. Should this gap persist, the United States risks importing the majority of the clean energy technologies necessary to meet growing domestic demand.

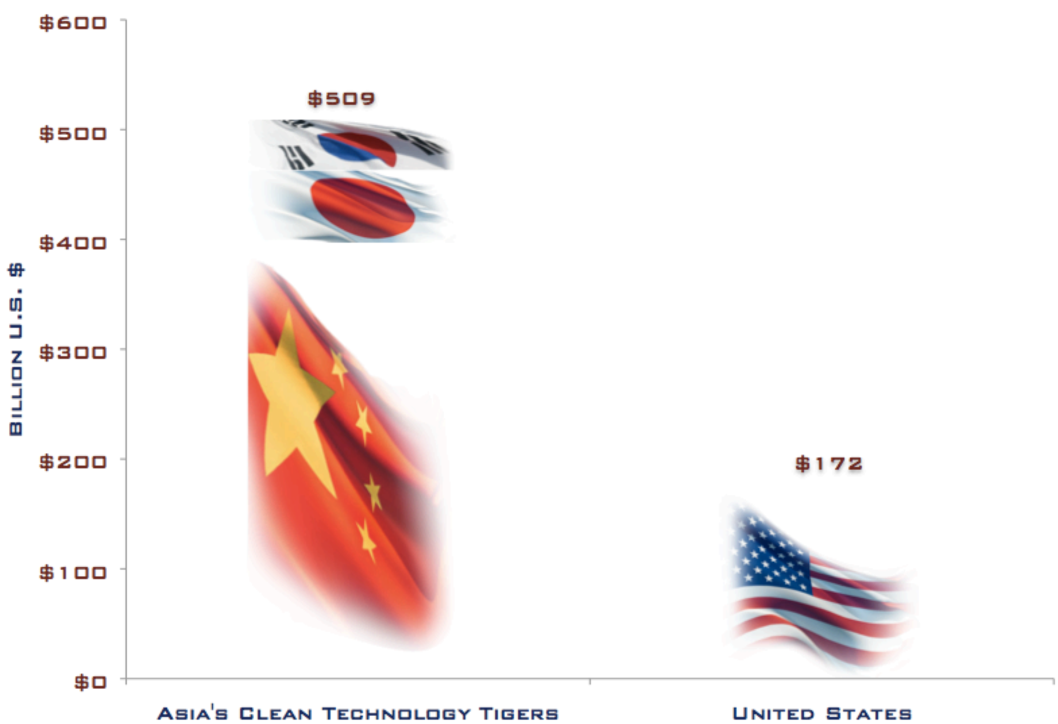
While the United States has traditionally attracted the bulk of available private investment in clean energy, capital flows are increasingly being directed towards Asia's clean tech tigers, and these nations' greater public investments are likely to capture much of the future private investment in clean energy technologies. Between 2000 and 2008, the United States attracted $52 billion in private capital for renewable energy technologies, while China attracted $41

* The term "clean energy technologies" can be variously defined. Throughout this document, unless otherwise specified, we refer to zero- or low-carbon energy generation and transportation technologies and efficient end-use energy technologies.

billion. China's share of global clean tech investment is rising each year, surpassing the United States for the first time in 2008.[5] According to a recent study by Deutsche Bank,[6] "generous and well-targeted [clean energy] incentives" in China and Japan will create a low-risk environment for investors and stimulate high levels of private investment in clean energy. These nations rely on a "comprehensive and integrated government plan, supported by strong incentives." In contrast, the investment firm notes, the United States is a "moderate-risk" country since it relies on "a more volatile market incentive approach and has suffered from a start-stop approach in some areas."

China, South Korea and Japan will invest a total of $509 billion in clean technology over the next five years (2009-2013) while the United States will invest $172 billion, a sum that assumes the passage of the proposed American Clean Energy and Security Act (ACESA) and includes current budget appropriations and recently enacted economic stimulus measures (both figures include investments in clean energy generation and advanced vehicle technologies, as well as rail, grid, and efficiency investments; see Appendix A for more).

Figure 1. Competing Public Investments in Clean Energy Technology, 2009-2013



Source: See Appendix B for breakdown of investments by nation.

The largest investments are being made by China, which is planning new direct investments totaling at least $440[7] to $660[8] billion over ten years. This investment is expected to focus primarily on low-carbon power, and is in addition to the $177 billion in stimulus funds China has already invested in clean technology, including rail and public transit.[9] South Korea recently announced it will invest $46 billion over five years in clean technology sectors – over one percent of the nation's gross domestic product (GDP) – with the explicit goal of increasing Korean firms' share of the global clean tech export market by eight percentage points. This "Green New Deal" investment program will focus in particular on solar, LED lighting, nuclear, and hybrid car technologies.[10] Japan will provide $33 billion in targeted deployment incentives for a number of clean energy technologies, including solar, hybrid-electric vehicles, and energy efficiency technologies, and plans to invest an additional $30 billion over the next five years to implement technological roadmaps that focus on achieving price and performance improvements in a suite of low-carbon technologies.[11]

Beyond their greater size, the direct and coordinated nature of these Asian nations' public investments will confer significant advantages by developing each of the areas necessary to achieve a competitive economic advantage in the clean energy industry: research and innovation, manufacturing, and domestic market demand, as well as supportive infrastructure. China is poised to replicate many of the same successful strategies that Japanese and South Korean governments used to establish a technological lead in electronics and automobiles. Those governments supported nascent companies with low-interest loans, industry-wide R&D, government procurement, and subsidies for private firms to drive the purchase of advanced technologies. China is now employing similar tactics in emerging clean technology industries such as electric cars and low-carbon power generation.[12]

Many of these investments are directed at growing domestic clean technology industries in order to meet aggressive technology deployment targets. By 2012, China, Japan, and South Korea plan to produce 1.6 million hybrid gas-electric or electric vehicles annually compared to North America, which is projected to produce 267,000, less than a fifth as many, according to industry forecasts.[13] Japan has unveiled a plan to boost domestic solar power capacity by a factor of 20 by 2020. The nation also plans to generate 20 percent of its electricity from renewable sources by 2020. Both objectives are backed up by targeted R&D investments, technology-specific deployment incentives, and government procurement programs. China plans to deploy up to 86 GW of new nuclear capacity by 2020, and is rapidly deploying wind and solar power spurred by guaranteed preferential tariff prices and, in many cases, low-interest financing. The country expected to generate between 15 to 18 percent of its electricity from renewable sources by 2020; Chinese officials have recently indicated this amount could reach 20 percent.

As Asia's clean tech tigers solidify their lead, they will capture economies of scale, learning-by-doing experience, supply chain efficiencies, and greater market power advantages. These "first-mover" advantages are likely to create significant challenges for late-to-market entrants. National investments in the deployment and procurement of new technologies will be used to help emerging domestic industries solve technology problems, improve manufacturing efficiency and product performance, and reduce price, providing a lasting competitive advantage over other firms and nations. Japan, for example, is using government procurement and other incentives to buy down the price of solar power and is engaging in targeted R&D efforts to drive price and performance improvements that could help it retain its status as a leading global producer of solar technology.[14]

Nations that establish an early lead in key industries can more easily retain that advantage at a lower cost over the long-term. Direct government investments by Asia's clean tech tigers will help them form industry clusters, like Silicon Valley in the United States, where investors, manufacturers, suppliers and others can establish dense networks of relationships that can provide cost and innovation advantages for participating firms, and for the nation as a whole.[15]

In order to avoid ceding first-mover advantage to Asia's clean tech tigers, U.S. support for the nation's already lagging domestic industries must be robust. Unfortunately, according to the Environmental Protection Agency (EPA), the climate and energy bill passed by the U.S. House of Representatives in June 2009 is not sufficiently aggressive to significantly increase the deployment of renewable and other low-carbon energy generation technologies or advanced vehicle technologies, particularly in the near-term.[16] When compared to investments made by the Asian competitors examined in this report, ACESA directs relatively little public funding to support research and development, commercialization and production of clean energy technologies within the United States. Furthermore, the legislation is unlikely to trigger significant private investments in clean energy development and deployment before 2020, if not much later, largely because carbon prices established by the bill's cap and trade program are projected to remain relatively low over this period and firms are expected to rely significantly on offsets for compliance with the legislation.[17] Renewable energy deployment standards contained in ACESA are also insufficient to require additional deployment beyond business-as-usual projections.[18]

Large government investments in China, Japan and South Korea are significant because, in contrast to many other industries, there are large barriers to the widespread commercialization of clean energy technologies.[19] These barriers include: high capital costs; significant uncertainty and risk; a lack of enabling infrastructure (e.g. transmission lines and storage for solar and wind); historically low levels of publicly funded R&D; low levels of privately funded R&D due to intellectual property concerns and spillover risks; and low to nonexistent competitive product differentiation in the energy sector, leaving emerging technologies to compete with well established incumbent technologies primarily on the basis of price alone.[20] As a result, the energy industry has remained one of the least innovative industries, with several of the dominant core technologies over a century old.

Public sector investments in new technologies have traditionally played a pivotal role in supporting emerging industries and catalyzing further private sector investment.[21] The U.S. Defense Department's procurement of microchips in the 1950s facilitated the technology's market penetration and dramatically reduced its cost. Today's vibrant information technology sector exists in large part because of early and sustained public investments in R&D, computer science, infrastructure, and the procurement of new technologies. Government investment was also crucial for the development of agriculture, railroads, radios, the Internet, aerospace, and pharmaceuticals.

Public investments have spurred the creation of clean technologies in past decades. Prior U.S. investments resulted in the invention of nuclear, wind, and solar energy technologies. Further price and performance improvements in wind turbines occurred in Denmark, where the government guaranteed its market for wind energy in the 1980s and 1990s and offered both targeted deployment incentives and supportive industrial R&D programs.[22] Today, Denmark's Vestas remains the world's top wind turbine manufacturer by capacity.

Since emerging clean energy technologies both remain more expensive than conventional alternatives and face a variety of non-price barriers, public sector investments in clean energy will be a key factor in determining the location of clean energy investments made by the private sector. Dollar for dollar, the direct and targeted public investments of China, Japan, and South Korea are likely to attract substantial private investment to clean energy industries in each country, perhaps more so than the market-based and indirect policies of the United States.[23]

As trillions of dollars are invested in the global clean energy sector over the next decade, clean tech firms and investors will invest more in those countries that offer support for infrastructure, R&D, a trained workforce, guaranteed government purchases, deployment incentives, lower tax burdens, and other incentives. In China, for example, local governments are offering firms free land and R&D money, and state-owned banks are offering loans to clean tech firms at much lower interest rates than those available in the United States.[24]

History offers examples of the United States catching up to competitors who have surged ahead. The United States raced past Europe in aerospace through sustained federal military-related support for aviation technology innovation and deployment, and was able to become a world leader in civil and military aviation after trailing Europe for years.[25] During the space race, the United States quickly met and then surpassed the Soviet Union after it launched the Sputnik satellite, putting a man on the moon twelve years later after a sustained program of direct investment in innovation and technology. The United States has consistently been a leader in inventing new technologies and creating new industries and economic opportunities. It remains one of the most innovative economies in the world, and is home to the world's best research institutions and most entrepreneurial workforce. The challenge will be for the United States to aggressively build on these strengths with robust public policy and government investment capable of establishing leadership in clean technology development, manufacturing, and deployment, and to do so before China, Japan and South Korea fully establish and cement their emerging competitive advantages.

Summary of Implications for U.S. Economic Competitiveness

Restoring America's competitiveness and ensuring U.S. leadership in the burgeoning clean energy sector will require a direct and sustained effort by the federal government to strengthen U.S. clean technology research and innovation, manufacturing capacity, and domestic markets. Establishing a price on carbon emissions, new energy standards, and other indirect incentives are necessary but are not sufficiently robust to support the growth of the U.S. clean energy sector and outcompete Asia's clean technology tigers. As China, Japan and South Korea all launch proactive and aggressive strategies to achieve technological and economic leadership in the clean energy sector, the United States will find it difficult to catch up without direct and targeted public investments of a similar scale. More aggressive measures will be required for the United States to regain the lead in the global clean energy race. The policy actions of these Asian competitors have important implications for U.S. policy and the steps that the U.S. government should take to strengthen the nation's competitive position:

| 1 |

The U.S. government should significantly increase investment in clean energy innovation by making a sustained commitment to research, development, and demonstration (RD&D).

A major boost in RD&D funding is necessary to improve the price and performance of clean energy technologies and gain a competitive advantage in the clean energy industry. Furthermore, without much greater investment in innovation, the United States risks seeing the next generation of clean technologies invented and commercialized overseas. The government of South Korea is poised to double its investment in clean energy R&D, and Japan plans to invest $30 billion over five years on research and development in low-carbon energy. Both Japan and South Korea have developed technology roadmaps that direct resources to technology R&D based on a thorough analysis of the economic and environmental potential of each technology and current institutional capacity to achieve technological leadership. The United States currently has no such strategy, and its investment in energy R&D has stagnated at low levels for years.[26] Along with increasing its commitment to clean energy research and development, the United States should explore new institutional structures to strengthen and augment the federal energy R&D system.[27] Furthermore, to ensure the timely commercialization of emerging technologies, the U.S. government should provide much greater funding to accelerate the commercial-scale demonstration of promising clean energy technologies, particularly in situations where the private sector is reluctant to commit funding to commercialize these nascent technologies.[28] A substantial and sustained increase of federal investment in clean energy RD&D will be necessary to regain economic leadership in the clean energy sector and to match the aggressive policies of our competitors.

| 2 |

The United States government should spur the adoption of innovative manufacturing processes and accelerate economies of scale in U.S. clean energy manufacturing.

Currently, China, Japan and South Korea are far outpacing the United States in manufacturing and producing the clean energy technologies that will underpin a new wave of economic growth. While low-carbon technology development benefits the entire world, real economic advantages are at stake for particular nations in the form of increased tax revenues, jobs, and the emergence of related industries and businesses along the clean energy technology value chain. The Chinese government is actively supporting the development of clean energy manufacturing centers in the country and is linking them with supporting financial and research institutions. To establish a competitive clean energy manufacturing industry in the United States, the government should provide or secure low-cost financing,[29] incentives,[30] and technical assistance[31] to retool the nation's industrial base and ensure that U.S. factories are commercializing and building the clean, cheap energy technologies to power America's economy and export abroad. Furthermore, a significant portion of U.S. research and development efforts should be located close to regional industry clusters and targeted to address manufacturing challenges and improve the design and production of clean technologies at scale.[32]

| 3 |

The United States government should actively support, through targeted public policy and investment, the acceleration of clean energy deployment and market creation in order to reduce the price of promising clean energy technologies and encourage their widespread adoption.

The U.S. government should provide sustained and targeted investments to spur a full suite of promising clean energy technologies, with a particular emphasis on closing the price gap between clean energy and incumbent fossil fuel energy sources. Pricing carbon can play a role here, but raising the costs of carbon-intensive energy sources through an economy-wide carbon price will not by itself provide the targeted support necessary to overcome technology-specific price gaps and other key barriers that inhibit the deployment of a full suite of clean energy technologies at scale. Asia's clean tech tigers are supporting clean energy technology adoption through a variety of targeted public policies, including technology-specific production incentives, government procurement offers and sustained and long-term lines of credit in the form of low-cost financing and credit guarantees. The U.S. government should similarly provide sustained financial and policy support for the deployment of clean energy at scale. Such incentives must be considered integral to any U.S. clean technology development and economic competitiveness strategy.[33]

Asia Seeks First-Mover Advantage Through Investments in Clusters

Government investments will be crucial to helping China, Japan, and South Korea gain a "first-mover" advantage over the United States in key clean energy sectors. Firms that can establish economies of scale and capture learning-by-doing and experience effects ahead of competitors can achieve lower cost production and/or higher quality products, effectively limiting their competitors market share and making it hard for new entrants to break into the market. This first-mover advantage accrues to nations as well as firms. While firms gain a first-mover advantage by being the quickest to develop, commercialize, and widely produce emerging technologies, nations can gain first-mover advantages by making investments to attract and grow leading firms, by fostering relationships between local firms, research labs, and universities, and by developing the associated infrastructure, human capital, and expertise that help firms become more competitive.

Direct government investments will help Asia's clean tech tigers form industry clusters, like Silicon Valley in the United States, where inventors, investors, manufacturers, suppliers, universities, and others can establish a dense network of relationships. Even in an era of increasingly globalized commerce, enduring competitive advantages lie increasingly in the structure of these regional economies.[34]

The governments of Asia's clean tech tigers are investing heavily to develop clean technology manufacturing and innovation clusters. In China, national, regional, and local governments are offering clean energy companies generous subsidies to establish operations in their localities, including free land, low-cost financing, tax incentives, and money for research and development. In just over three years, the Chinese city of Baoding has transformed from an automobile and textile town into the fastest growing hub of wind and solar energy equipment makers in China.[35] The city is home to "Electricity Valley," an industrial cluster modeled after Silicon Valley, composed of nearly 200 renewable energy companies focusing on wind power, solar photovoltaics (PV), solar thermal, biomass, and energy efficiency technologies. Baoding is the center of clean energy development in China, and operates as a platform that links China's clean energy manufacturing industry with policy support, research institutions, and other social systems.[36]

In Jiangsu, a province on the eastern coast of China, local government officials have enacted aggressive solar subsidies to reach a target of 260 MW of installed capacity by 2011. Jiangsu already houses many of China's major solar PV manufacturers, and the new policy is targeted to create substantial market demand and attract a cluster of polysilicon suppliers and solar technology manufacturers.[37] Another Chinese city, Tianjin, is now home to Vestas' largest wind energy equipment production base. The base will not only enhance the company's production capacity, but will also increase the localization of wind turbine equipment and help component suppliers develop expertise with the company's advanced wind power technology.[38]

Japan has an explicit industrial cluster program to strengthen the competitiveness of its domestic industries.[39] The Japanese government is funding R&D collaborations between government, academia, and industry while offering coordinated deployment incentives in order to achieve price and performance improvements in a suite of technologies that can improve the productivity of domestic industry. Likewise, South Korea is providing billions in R&D funding and credit guarantees to drive private investment in clean energy technologies.

Clusters provide cost and innovation advantages, including access to specialized labor, materials, and equipment at lower operating costs, as well as lower search costs, economies of scale, and price competition.[40] Clusters provide members with preferred access to market, technical, and competitive information, creating knowledge spillovers that can accelerate the pace of innovation. Relationships between companies are leveraged to help them learn about evolving technologies as well as new market opportunities. Workforce mobility further facilitates knowledge spillovers that can enhance the rate of innovation for the whole cluster. These clusters can provide an attractive business environment for particular industries; if one or two companies fail or move out of the area, others can quickly replace them.

Notable examples of competitive economic clusters include Detroit's historic leadership in auto technology, Silicon Valley's long dominance in successive waves of information technology, and biotechnology and pharmaceutical firms clustered around the Philadelphia area. The United States established strong first-mover advantages in each of these industries by developing clusters that fostered relationships among related organizations and value-added industries, which enhanced overall industry productivity. These advantages made it costly for other nations to catch up.

Establishing industrial clusters does not guarantee continued market dominance. In the case of the automotive industry, U.S. firms eventually lost market dominance after East Asian nations spent years implementing an industrial policy that sheltered their nascent auto industry from competition and invested billions in direct subsidies to support the industry's growth and technological progress. In the face of this dedicated international competition, and its own failure to innovate and adapt, the U.S. auto industry faltered.

Continual investment in innovation is also critical. New technologies disrupt existing markets, and new technology clusters can likewise disrupt the established geographic concentration of industry dominance. Such was the case when, in the 1980s, the transformation of the computer industry away from mainframes and then minicomputers led to a shift of dominance from the northeastern United States to Silicon Valley.[41] This could likely prove true for clean energy as well, as major investments in emerging technologies form new geographic concentrations of industrial and technological leadership.

The United States has natural innovation advantages, including a skilled workforce, world-class universities and research institutes, fluid capital markets, an open society and vibrant creative culture. However, given the dynamics of first-mover national advantage and the aggressive measures now being taken by Asian competitors in the clean energy sector, these advantages will by no means be sufficient for the United States to retain its innovative edge. A recent report by the Information Technology and Innovation Foundation (ITIF) ranked the United States sixth out of 40 leading industrialized nations in innovation competitiveness, and last in the rate of improvement in national innovation competitiveness over the last decade — America's economic competitors are surging ahead while U.S. innovation capacity stagnates.[42] Particularly in this new 21st century growth industry, many nations are starting from a more even position. Ultimately, economic success in the clean energy race will be determined in large part by the public investments made by competing nations. Without much larger public investments in clean technology, the United States risks being out-innovated by its economic competitors.

Barriers to Widespread Clean Energy Adoption and the Public Investment Imperative

Financial and non-financial barriers prevent the widespread deployment and commercialization of clean energy technologies. The persistence of such barriers leads private investors to under-invest in clean energy deployment and innovation, and they are often referred to as "market failures," a term that implies that these barriers can be corrected through market mechanisms. However, many of the pervasive barriers that inhibit the widespread adoption of clean energy technologies cannot be solved by market signals alone.

Four barriers, in particular, are indicative of the challenges to large-scale clean energy deployment, and along with other obstacles are major reasons why the energy sector has remained one of the least innovative sectors of the global economy.[43] **First,** a significant price differential exists between clean energy and fossil fuels. While there is a strong case that the full societal costs of fossil fuel use (e.g. carbon emissions) are not incorporated into their price, governments have been unwilling to raise the price of fossil fuels high enough for most clean energy technologies to become cost competitive.[44] As a result, without public policy support, the costs of these newer technologies are too high relative to well-established fossil fuels, and their performance and expected rate of return too low, to justify significant private sector investments in their widespread deployment.

Second, individual firms are discouraged from making large investments in research and development because the knowledge created by such investments may spill over to other firms. In these cases of "knowledge spillover," firms are unable to fully capture the benefits of their investments, leading to under-investment by private firms in basic and applied research.[45] There are strong indications that these risks are particularly challenging for the energy sector. The U.S. energy sector invests less than one quarter of one percent of annual revenues in R&D activities,[46] just one-tenth of the average across all U.S. industries (2.6 percent of revenues).[47] As a portion of annual revenues, U.S. energy sector R&D investments are two orders of magnitude lower than leading innovation-intensive sectors such as biomedical technology (10-20 percent of annual revenues invested in R&D each year), semiconductors (16%), and information technology (10-15%).[48]

Third, the scale and long time horizon of many clean energy projects, combined with considerable market and technology uncertainty, makes it extremely difficult for firms to assess expected rates of return on investments. This high level of uncertainty discourages high-risk, high-reward research in favor of short-term research and incremental product development, while simultaneously inhibiting the commercialization and adoption of technologies that require capital-intensive projects to demonstrate technological and financial performance at commercial scale.[49]

Fourth, current energy infrastructure has been established to accommodate and support incumbent technologies, not emerging challengers. For example, national electricity grids are tailored for large centralized thermal power plants, while renewable energy generation facilities are generally smaller, must be located near resource-rich areas, and frequently require new transmission capacity to reach markets.[50] New transmission lines must typically serve multiple energy projects to secure financing and to be profitable, and individual clean energy project developers and investors are unlikely to shoulder the cost of network expansion on their own. Coordination between project developers could help to solve this problem, but such coordination has proven difficult, since each project depends on its own funding, planning, and energy contract processes that can be uncertain and unpredictable.[51] Similarly, a ubiquitous refueling infrastructure exists for conventional gasoline vehicles, while electric or alternative fuel vehicles require the establishment of new refueling systems. The lack of enabling infrastructure for emerging clean energy technologies therefore inhibits their widespread diffusion and large-scale deployment.

The dominant policy approach to improving U.S. economic competitiveness in clean energy has been focused on establishing a price on emissions of carbon dioxide and other global warming pollutants along with new efficiency and renewable energy regulations, but these efforts cannot succeed on their own for several reasons. **First,** for many clean energy technologies to be competitive with fossil fuels, governments would have to set very high prices for carbon pollution, and typically governments face stiff political resistance to doing so.[52] Thus, political considerations mean that any carbon price established will be relatively low, as in currently pending U.S. climate and energy legislation, which would establish a price averaging roughly $15 per ton of CO2-equivalent for the first decade of the program (2012-2021) – the equivalent of a roughly 15 cent increase in the price of a gallon of gasoline.[53]

Second, an economy-wide carbon price would not overcome specific barriers to the adoption of particular technologies. While a modest carbon price may help some lower-cost and more mature clean energy technologies (e.g., wind power) become more competitive with fossil fuels, it will do little for less mature and currently more expensive technologies such as solar energy or carbon capture and storage. Furthermore, carbon prices clearly cannot solve the many non-price barriers specific to the adoption of emerging clean technologies.[54]

Third, even a high carbon price will not solve the problem of knowledge spillover and the long-term risks associated with large private investments in technology development and deployment. Nor will it facilitate the establishment of critical infrastructure, such as new transmission lines, grid upgrades, or storage for intermittent sources like wind and solar.[55]

Given each of these limitations, there is wide expert consensus[56] around the need for significant, targeted public investment to overcome these key barriers, particularly to boost the performance of current clean energy technologies and decrease the cost of deploying them. Governments can help remove or overcome barriers to clean energy adoption by making investments that private investors are unable or unwilling to make and by shifting the incentive structure faced by private firms in order to encourage greater private investment in clean energy technologies. Public investments in research and development can help fill the innovation gap that results from a private sector constrained by risks of knowledge spillover and other market failures.[57] These investments are necessary to both accelerate the invention of new technologies and improve the price and performance of existing technologies, increasing their appeal to market adopters.

Public investment can similarly bridge the initial price differential between clean energy technologies and their incumbent competitors. Unlike economy-wide carbon prices or market mechanisms, these public investments and incentives can be targeted to address the varying price differentials for a full suite of clean technologies at various stages of maturity and development. These investments in turn accelerate reductions in the real, unsubsidized cost of emerging clean technologies over time. New technologies routinely become less expensive with increasing experience and scale, as supply chain and production efficiencies are captured and economy of scale effects are realized. This "learning-by-doing" effect, brought about through operational market experience, also feeds back into the research process to guide future research and improvements in product performance and price.[58]

Public investments in enabling infrastructure, such as electricity grid expansion or electric car charging stations, lower barriers to clean technology adoption by offering greater market access for private firms. Similarly, public support for clean energy financing, in the form of low-cost loans, credit guarantees, tax incentives, and direct project grants, reduces private sector project risk. Given the persistence of the multiple barriers to clean energy technology adoption discussed above, public investment will be a key determinant of future private sector investment in the industry and the resulting pace and scale of market growth for emerging clean energy technologies.

A Summary of Competing Clean Energy Industries

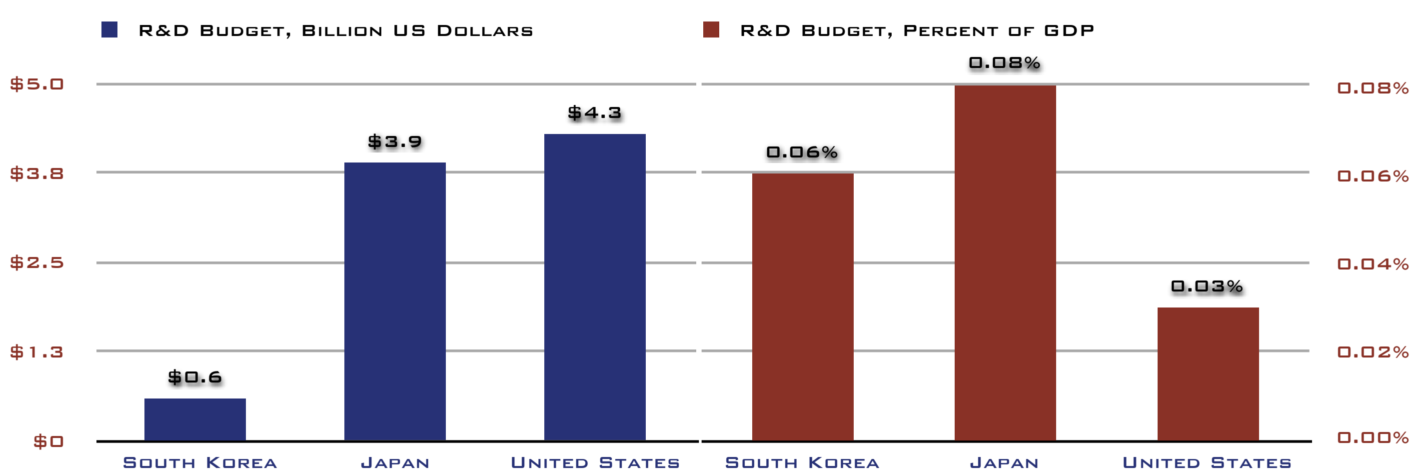
Asia's "clean technology tigers" – China, Japan, and South Korea – are aggressively challenging the United States for economic dominance in the global clean technology industry. A comprehensive national strategy to achieve economic leadership in clean energy technology involves three critical components: clean technology **research and innovation**, **manufacturing** capacity, and the development of **domestic markets**. In each of these three critical areas, the United States is either behind, or is being aggressively challenged by its economic competitors.

The United States only slightly edges out Japan in clean energy research and innovation capacity, and South Korea and China are moving quickly to fill the innovation gap. The United States lags behind at least one of its economic competitors in the production and manufacturing of each of the six technologies examined in this report: solar, wind, nuclear, carbon capture and storage (CCS), advanced vehicles and battery technology, and high-speed rail. With respect to domestic market development, the United States leads its economic competitors in solar, wind, and CCS market development (although China is quickly gaining ground in each), is currently neck and neck in advanced vehicles, and is falling far behind its economic competitors in nuclear power and high-speed rail.

Research and Innovation

The United States currently invests slightly more money in research and development than Japan and has an advantage over China and South Korea. However, each Asian competitor is moving to close the innovation funding gap. Furthermore, as a percentage of each nation's gross domestic product (GDP), Japan and South Korea out-invest the United States on energy innovation by a factor of two-to-one. The United States secures 20.2 percent of the world's clean energy patents—a measure of innovation in the clean energy sector—more than any country in the world. Japan is close on America's heels, however. In addition to almost matching U.S. energy R&D spending in 2008, Japan achieves a nearly equivalent number of international clean energy patents.

Figure 23. Comparative Government Energy R&D Investments, 2008



Source: IEA Energy R&D Statistics, Author's Analysis; Data not available for China.

Clean Energy Manufacturing

The United States has fallen behind its economic competitors, especially China, in the capability to manufacture and produce clean energy technologies on a large scale. The United States is behind both China and Japan in the production of solar PV cells, and China now manufactures twice the amount of wind turbine components as the United States. All three Asian nations have the heavy engineering and manufacturing capacity to produce full component sets for new nuclear reactors, and all now have their own domestic nuclear reactor designs. While the United States was an early pioneer in nuclear reactor technology and retains domestic production of some nuclear components, it has seen a decline in nuclear engineering facilities and does not have the large heavy forging capacity necessary to produce full nuclear reactor sets, especially those necessary for the large advanced nuclear power plants being developed today.

The United States is currently being aggressively challenged by its Asian competitors in the race to develop the next generation of advanced vehicles—plug-in hybrid and electric cars—as well as the lithium-ion batteries that will power them. China, Japan, and South Korea collectively manufacture over 80 percent of the world's lithium-ion batteries as storage devices, and all four nations are moving quickly to release or scale-up manufacturing of their first mass-market electric and plug-in hybrid vehicle models. Asia's clean tech tigers are also far ahead of the United States in the development of high-speed rail technology. Japan has long been a technological leader in HSR, and both South Korea and China are engaging in successful strategies to localize production and develop domestic HSR technologies. The United States, by contrast, does not manufacture any high-speed rolling stock, and all future plans for high-speed rail deployment may require international imports.

Table 2. Comparative Domestic Manufacturing Capacity by Clean Energy Technology

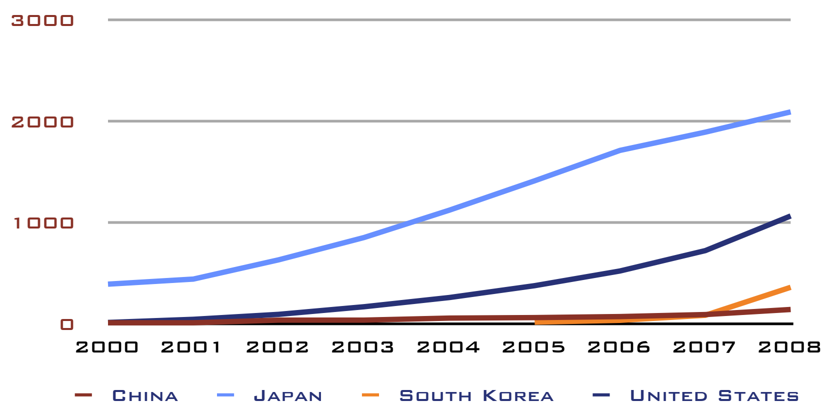
	Solar PV (Manufacutring Capacity)	Wind Power (Manufacturing Capacity)	Nuclear (Manufacturing Capacity)	Advanced Vehicles (Initial Produciton Date)	High-Speed Rail (Number of Domestic Designs)
China	1,800 MW	8 GW*	7 reactor sets (15,000 ton max heavy forging capacity)	EV: BYD E6 (2010) PHEV: BYD F3DM (2009)	4
South Korea	60 MW	Data not available (see Korea section above)	Data not available for reactor sets (13,000 ton max heaving forging capacity)	EV: Hyundai i10 (2010) PHEV: Hyundai Blue-Will (2012)	2
Japan	1,200 MW	Data not available (see Japan section above)	4+ reactor sets (two 14,000 ton heaving forging presses)	EV: i-MiEV (2009) PHEV: Toyota Prius (2012)	14
United States	375 MW	4.2 GW	No full sets (10,000 ton max heavy forging capacity)	EV: Tesla Roadster (2009) PHEV: Chevy Volt (2010)	0

Note: *2007 figure, data for 2008 unavailable.

Domestic Clean Energy Markets

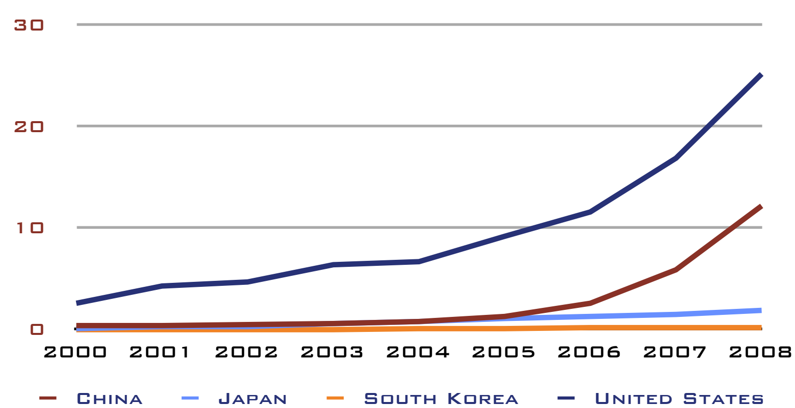
The United States currently leads China, Japan, and South Korea, in the domestic market development of three of the six technologies surveyed in this report, including solar PV, wind power, and the nascent market for CCS technology. The United States has experienced strong growth in the deployment of solar PV and wind power, but other nations are quickly catching up. The United States was the largest market for wind in 2008 and surpassed Germany as the leader in total installed capacity at the end of that year. China's wind market, however, was not far behind in 2008, and China is expected to surpass the United States as the largest market for wind in 2009. The United States also led each of the three Asian nations in annual solar PV capacity in 2008, although Japan continues to be the leader of the pack with respect to total installed solar PV capacity. There are currently more CCS demonstration sites being developed throughout the United States than anywhere in Asia. The United States has three such sites operational now, and a further 16 planned.

Figure 24. Comparative Domestic Solar Markets, 2000-2008 (Cumulative Installed Megawatts)



With respect to advanced vehicles, all four nations are vying for leadership in domestic market development. China has introduced the world's first mass-market plug-in hybrid vehicle to its domestic market. The other three nations will introduce plug-in hybrids to their respective markets by 2012. Japan and the United States each have serially-produced electric cars on their roads right now (albeit in small numbers). Markets for each of these technologies are still nascent, and a clear world leader has yet to emerge.

Figure 25. Comparative Domestic Wind Markets, 2000-2008 (Cumulative Installed Gigawatts)



The United States currently lags behind its competition in market development for two of the six technologies surveyed in this report: nuclear power and high-speed rail. Despite having the world's largest installed nuclear power capacity, the United States has no new nuclear power plants under construction, while China leads the pack with seventeen. While the United States has no high-speed rail (HSR) capacity to speak of and is still years away from breaking ground on the nation's first true high-speed line, each of its three Asian competitors has a large and growing domestic market for this clean technology. Japan has been a historic leader in HSR since the 1960s and has a fully developed domestic network spanning more than 1,500 miles. South Korea, the second nation in Asia to deploy HSR, is in the midst of constructing a nationwide network of high-speed lines. China's market for HSR technology is poised to become the largest among the four nations examined, however, as the country moves rapidly to construct a nationwide high-speed rail network with plans to ultimately connect all major Chinese cities with HSR service.

Figure 26. Comparative Domestic Nuclear Markets

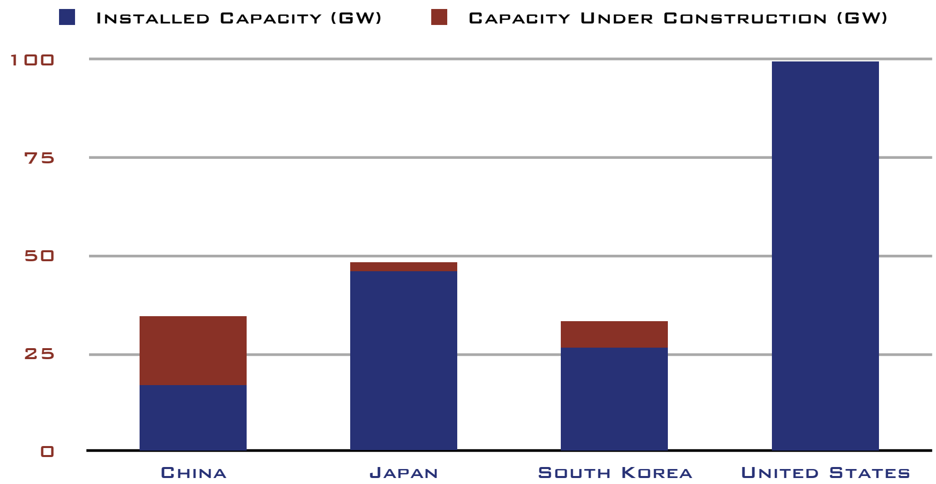


Figure 27. Comparative Domestic CCS Markets (Number of Pilot Projects)

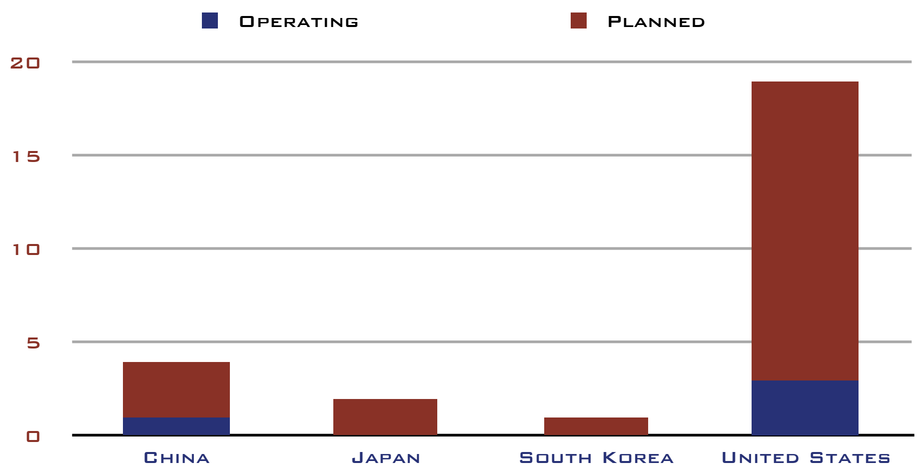
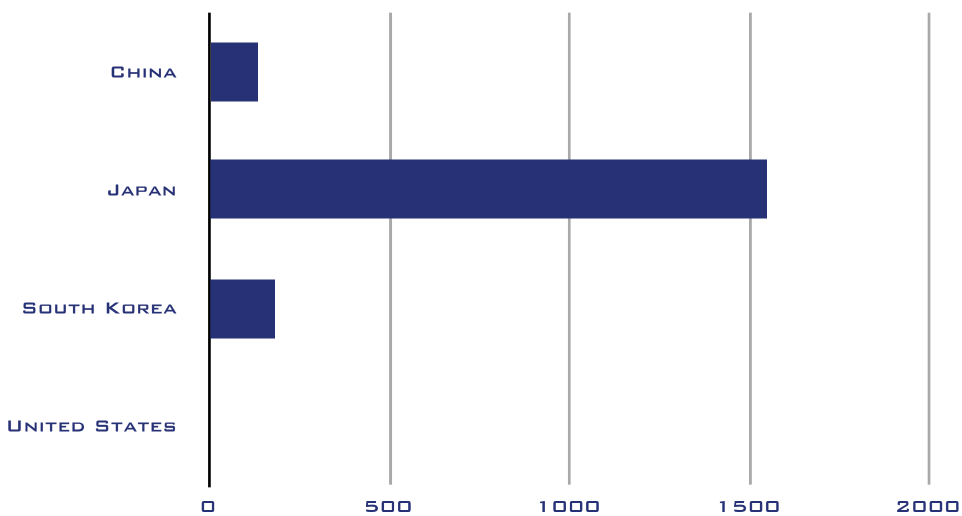


Figure 28. Comparative High-Speed Rail Markets (Miles of Track Installed)



Conclusions and Implications

As this report documents, Asia's "clean technology tigers" plan to build on their current advantages in the global clean technology sector by making large and sustained investments to support clean technology research and innovation, manufacturing, domestic markets, and the establishment of critical infrastructure. Over the next five years, the governments of China, Japan, and South Korea plan to invest a total of $509 billion in domestic clean technology industries. By contrast, the United States government will invest just $172 billion over the same period.

The largest investments will be made by China, which will soon announce a renewable energy stimulus package reported to be valued at $440 to $660 billion over ten years. Japan plans to invest $66 billion over the next five years in clean energy technology, with a focus on improving the current generation of clean technology and reducing their costs while scaling up domestic industries. South Korea will invest $46 billion on clean energy technology over the next five years, a full one percent of its GDP; were the United States to invest an equivalent portion of the nation's resources in clean technology, it would spend nearly $140 billion annually.

In addition to the larger scale of clean energy investments in China, Japan, and South Korea, the clean technology policies of the United States' Asian competitors are more long-term and more directly formulated to overcome barriers to individual technologies. These targeted policies, such as national feed-in tariffs and technology installation subsidies, as well as support for clean tech manufacturers and major investments in clean energy infrastructure, are likely to offer a lower risk environment for private investors, attracting the bulk of future private investment in clean technologies, expected to be in the trillions of dollars over the next decade.

There are a number of barriers that prevent the widespread adoption of clean energy technologies by private market adopters, and four in particular are described in this report. The first major barrier is the significant price differential that exists between clean energy and fossil fuels. The costs of these new technologies are too high, and their return on investment too low, to justify large-scale private investment in their widespread deployment. Second, firms are discouraged from making large investments in clean energy research and development because of technology spillover risks that prevent them from capturing the full value of their investments. Third, the scale and long time horizon of most clean technology projects makes it difficult to assess expected rates of return on investments, creating unacceptable levels of financial risk and inhibiting private investment. Lastly, new clean energy technologies frequently require the establishment of new enabling infrastructure, as current energy systems are designed to accommodate incumbent technologies, not emerging challengers.

The long-term and targeted clean energy public policies of Asia's clean tech tigers will help address many if not most of these barriers, generating greater private market investment in domestic clean technology industries. In order to bridge the price gap between clean energy technologies and fossil fuels, and to provide greater investor certainty in domestic clean technology markets, these three nations are enacting clean energy procurement policies and long-term policies to buy down the costs of clean energy generation.

China has implemented feed-in tariffs for wind power generation set to correspond to variable wind resources. China will soon adopt a new feed-in tariff policy for utility-scale PV plants, a plan that has already helped secure a deal to construct the world's largest solar power plant within the country. China is adopting procurement policies to drive the widespread adoption of electric vehicles, and the government is financing the majority of the nation's major expansion of high-voltage electrical transmission and high-speed rail networks. South Korea has targeted feed-in tariffs policies that offer premiums on electricity generated by a suite of low-carbon energy technologies, including solar PV and wind. Japan has enacted installation subsidies and procurement policies to increase solar PV adoption, and in November 2009 instated a new feed-in tariff for solar electricity.

To overcome barriers to research and innovation, all three Asian nations are extending their public commitments to energy research and development. The Japanese government plans to spend $30 billion over five years implementing low-carbon technology roadmaps to reduce the cost and improve the performance of emerging clean energy technologies. South Korea is doubling its investment in energy R&D over the next five years and China is strengthening its nascent energy innovation capacity.

These nations are also investing heavily in new energy infrastructure to help accelerate the deployment of new clean technologies. Each nation is investing in the construction of new electric-vehicle charging infrastructure to enable greater adoption of plug-in hybrid and electric vehicles. To accelerate the deployment of clean energy generation technologies, China is investing $44 billion through 2012 in new ultra high voltage (UHV) power lines, while South Korea is funding the construction of a nationwide smart grid by 2030.

Proposed climate and energy policy in the United States, by contrast, is less targeted, more volatile, and may create a higher risk environment for investors. While the direct technology investments and other incentives in the U.S. Emergency Economic Stabilization Act (EESA) and the American Recovery and Reinvestment Act (ARRA) have provided a major boost for domestic clean technology industries—the two stimulus measures will provide just over $81 billion for clean technology over the next five years—a level of direct support that is not sustained under the American Clean Energy and Security Act (ACESA) passed by the U.S. House of Representatives in June 2009. The ACESA climate and energy bill would invest just $29 billion to support U.S. clean energy industries over the next five years, a step backwards from funding levels begun under U.S. economic stimulus measures and far short of investments planned by Asia's clean tech tigers.

Moreover, as the primary mechanism to incentivize clean technology adoption, the ACESA legislation would establish an economy-wide carbon price that is expected to remain low (an average of $15 per ton CO2-equivalent) for at least the next decade, a level insufficient to provide a significant near-term boost to U.S. competitiveness in clean energy technology. This market-incentive based policy is likely to create more risks for private clean technology investors because the incentive is not sufficiently strong (i.e. the carbon price is low), it is not targeted to the requirements of individual technologies, and because it does little to address the many non-economic barriers to clean technology adoption, including grid access, energy storage, and spillover risks from investments in energy innovation.

Implications for U.S. Economic Competitiveness

The clean energy race may become one of the defining global economic competitions of the 21st century. The latest trends in the global clean technology industry suggest that Asia's rising clean tech tigers are positioning themselves to gain first-mover advantages and capture market share in the burgeoning clean energy sector.

Fortunately, not all the indicators portend a loss of dominance for the United States and the nation retains an entrepreneurial spirit and world-class innovative capacity. Historic examples of U.S. action offer models for how the nation can regain the lead in clean energy. One of the most salient examples is early aviation and aerospace. In the early 20th century, the United States, through sustained federal support for aviation technology development and deployment, became a world leader in civil and military aviation, after trailing its European counterparts for years.[463] Likewise, during the space race, the United States quickly met and then surpassed the Soviet Union after it launched the Sputnik satellite, putting a man on the moon twelve years later with the support of a sustained program of direct investment in innovation and technology. This era of large-scale public investment in technology supported successive waves of innovation, paving the way for the information technology revolution and decades of U.S. economic growth.

Restoring America's competitiveness and ensuring U.S. leadership in the burgeoning clean energy sector will require a direct and sustained effort by the federal government to strengthen U.S. clean technology research and innovation, manufacturing capacity, and domestic markets.

Establishing a price on carbon emissions, new energy standards, and other indirect incentives are necessary but are not sufficiently robust to support the growth of the U.S. clean energy sector and outcompete Asia's clean technology tigers.

As China, Japan, and South Korea all launch proactive and aggressive strategies to achieve technological and economic leadership in the clean energy sector, the United States will find it difficult to catch up without direct and targeted public investments of a similar scale. More aggressive measures will be required for the United States to regain the lead in the global clean energy race. The policy actions of China, Japan, and South Korea have important implications for U.S. policy and the steps that the U.S. government should take to strengthen the nation's competitive position:

| 1 |

The U.S. government should significantly increase investment in clean energy innovation by making a sustained commitment to research, development, and demonstration (RD&D).

A major boost in RD&D funding is necessary to improve the price and performance of clean energy technologies and gain a competitive advantage in the clean energy industry. Furthermore, without much greater investment in innovation, the United States risks seeing the next generation of clean technologies invented and commercialized overseas. The government of South Korea is poised to double its investment in clean energy R&D, and Japan plans to invest $30 billion over five years on research and development in low-carbon energy. Both Japan and South Korea have developed technology roadmaps that direct resources to technology R&D based on a thorough analysis of the economic and environmental potential of each technology and current institutional capacity to achieve technological leadership. The United States currently has no such strategy, and its investment in energy R&D has stagnated at low levels for years.[464] Along with increasing its commitment to clean energy research and development, the United States should explore new institutional structures to strengthen and augment the federal energy R&D system.[465] Furthermore, to ensure the timely commercialization of emerging technologies, the U.S. government should provide much greater funding to accelerate the commercial-scale demonstration of promising clean energy technologies, particularly in situations where the private sector is reluctant to commit funding to commercialize these nascent technologies.[466] A substantial and sustained increase of federal investment in clean energy RD&D will be necessary to regain economic leadership in the clean energy sector and to match the aggressive policies of our competitors.

| 2 |

The United States government should spur the adoption of innovative manufacturing processes and accelerate economies of scale in U.S. clean energy manufacturing.

Currently, China, Japan and South Korea are far outpacing the United States in manufacturing and producing the clean energy technologies that will underpin a new wave of economic growth. While low-carbon technology development benefits the entire world, real economic advantages are at stake for particular nations in the form of increased tax revenues, jobs, and the emergence of related industries and businesses along the clean energy technology value chain. The Chinese government is actively supporting the development of clean energy manufacturing centers in the country and is linking them with supporting financial and research institutions. To establish a competitive clean energy manufacturing industry in the United States, the government should provide or secure low-cost financing,[467] incentives,[468] and technical assistance[469] to retool the nation's industrial base and ensure that U.S. factories are commercializing and building the clean, cheap energy technologies to power America's economy and export abroad. Furthermore, a significant portion of U.S. research and development efforts should be located close to regional industry clusters and targeted to address manufacturing challenges and improve the design and production of clean technologies at scale.[470]

| 3 |

The United States government should actively support, through targeted public policy and investment, the acceleration of clean energy deployment and market creation in order to reduce the price of promising clean energy technologies and encourage their widespread adoption.

The U.S. government should provide sustained and targeted investments to spur a full suite of promising clean energy technologies, with a particular emphasis on closing the price gap between clean energy and incumbent fossil fuel energy sources. Pricing carbon can play a role here, but raising the costs of carbon-intensive energy sources through an economy-wide carbon price will not by itself provide the targeted support necessary to overcome technology-specific price gaps and other key barriers that inhibit the deployment of a full suite of clean energy technologies at scale. Asia's clean tech tigers are supporting clean energy technology adoption through a variety of targeted public policies, including technology-specific production incentives, government procurement offers and sustained and long-term lines of credit in the form of low-cost financing and credit guarantees. The U.S. government should similarly provide sustained financial and policy support for the deployment of clean energy at scale. Such incentives must be considered integral to any U.S. clean technology development and economic competitiveness strategy.[471]

Endnotes

Executive Summar and Introductory Sections

1 Mark World Economic Forum, "Green Investing: Toward a Clean Energy Infrastructure,," (Geneva, Switzerland: WEF, January 2009), http://www.weforum.org/pdf/climate/Green.pdf.

For example, a recent opportunity estimate for China alone predicted a maximum market opportunity of $500 billion to $1 trillion by 2013. China Green Tech Initiative, "The China Greentech Report 2009," (September 10, 2009) 16, http://www.china-greentech.com/report

2 For example, a recent opportunity estimate for China alone predicted a maximum market opportunity of $500 billion to $1 trillion by 2013. "The China Greentech Report 2009." China Green Tech Initiative (September 10, 2009), 16, http://www.china-greentech.com/report.

3 John Collins Rudolf, "China-U.S. Group Plans to Build Texas Wind Farm," The New York Times, (New York, New York), October 29, 2009, http://www.nytimes.com/2009/10/30/business/energy-environment/30wind.html

4 Wind: Through the 3rd quarter of 2009, 55 percent of installed turbines were manufactured from foreign companies, as well as 67 percent of the turbines slated for projects currently under construction. Source: Russ Choma, "Overseas Firms Collecting Most Green Energy Money," Investigative Reporting Workshop, (Washington, D.C.: American University School of Communications, 2009), http://investigativereportingworkshop.org/investigations/wind-energy-funds-going-overseas/; Solar: Marketbuzz 2009, "Annual World Photo Voltaic Industry Report," Solarbuzz (San Francisco, California: March, 2009), 130, http://www.solarbuzz.com/Marketbuzz2009-intro.htm .

Vehicles: Keith Bradsher, "China Vies to be World Leader in Electric Cars," New York Times, (New York, New York) April 1, 2009, http://www.nytimes.com/2009/04/02/business/global/02electric.html.

5 Deutsche Bank Climate Change Advisors, "Global Climate Change Tracker: An Investor's Assessment," (Frankfurt, Germany: Deutsche Bank Group, October 2009), http://www.dbcca.com/dbcca/EN/investment-research/investment_research_1780.jsp See also: United Nations Environmental Program, "Global Trends in Sustainable Energy Investment," (London, United Kingdom: UNEP, 2009), http://sefi.unep.org/english/globaltrends1.html#c2322.

6 Deutsche Bank Climate Change Advisors, October 2009.

7 "China Plans 440-bln dlr stimulus for Green Energy." Agence France Press, May 24, 2009, http://www.google.com/hostednews/afp/article/ALeqM5i7wWkoCABy_Y7poh8ym0TI7CjJjA.

8 "The scale of the total investment planed for new energy may reach 4.5 Wan Yi," translated by Gang Lin, http://money.163.com/09/0526/16/5A8JM34S00252G50.html.

9 Nick Robins, Robert Clover, and Charanjit Singh, "A Climate for Recovery: The Colour of Stimulus Goes Green," (London, United Kingdom: HSBC Global Research, February 2009), 2, http://www.globaldashboard.org/wp-content/uploads/2009/HSBC_Green_New_Deal.pdf.

10 A number of reports have put South Korea's investment figure at around $84 billion, but this includes a number of investments that are unrelated to clean energy technology. While details of South Korea's investment package have not been completely specified, a preliminary accounting of the investment package puts the clean energy total at $46 billion. This figure excludes investments in water and waste management. Nick Robins, Robert Clover, and Charanjit Singh, "A Global Green Recovery? Yes, but in 2010," (London, United Kingdom: HSBC Global Research, August 6, 2009), 2.

See also: Kim Hee-Sung, "Gov't Unveils Plan to be Among the Top Green Nations," Korea.net: Korea's Official Website, (South Korea: Government of South Korea) July 7, 2009, http://www.korea.net/news/issues/issueDetailView.asp?board_no=20963.

11 Council of Science and Technology Policy, "Low Carbon Technology Plan," (Japan: Government of Japan, May 19, 2008), http://www8.cao.go.jp/cstp/english/doc/low_carbon_tec_plan/low_carbon_tech_plan.pdf.

12 Keith Bradsher, "China Vies to be World Leader in Electric Cars," April 1, 2009.

13 Keith Bradsher, "China Vies to be World Leader in Electric Cars," April 1, 2009.

14 See "Asia Seeks First-Mover Advantage Through Investments in Clusters" in this report.

15 See "Asia Seeks First-Mover Advantage Through Investments in Clusters" in this report.

16 U.S. Environmental Protection Agency, "Analysis of H.R. 2454 in the 111th Congress, the American Clean Energy and Security Act of 2009." (Washington, D.C.: EPA, June 2009), http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis.pdf.

17 The U.S. Environmental Protection Agency projects carbon prices under the House-passed American Clean Energy and Security Act (ACESA) would rise to just $13 per ton of CO2-equivalent (CO2-e) by 2015, while the Congressional Budget Office projects a price of $16 per ton CO2-e in 2012, rising to $17 per ton in 2013 and $19 per ton in 2015. See U.S. Environmental Protection Agency, June 2009; U.S. Congressional Budget Office, "H.R. 2454, American Clean Energy and Security Act of 2009," (Washington, D.C.: June 2009), http://www.cbo.gov/ftpdocs/102xx/doc10262/hr2454.pdf.

In contrast, CO2 permit prices in the European Union's Emissions Trading Scheme (ETS) have regularly traded at above $30 per ton CO2-e during the current compliance phase (Phase II) and preferential production incentives for solar power, for example, offered in China, Japan, the EU and elsewhere routinely top the CO2 price equivalent of $200-500 per ton (roughly equivalent to production incentives or tariff prices of $0.20-0.50 per kilowatt-hour).

Furthermore, both of the EPA and CBO forecasts were published prior to revised emissions projections for 2009 taking into account the impacts of the global economic recession and resulting significant drop in U.S. CO2 emissions. Analysts now project a potential over-allocation of emissions permits in the early years of the ACESA cap and trade program, which may collapse carbon prices down to the $10 per ton CO2-e floor price for primary auction markets established by the legislation, with secondary markets potentially trading below this nominal floor. See Jesse Jenkins, Ted Nordhaus, and Michael Shellenberger, "Over-Allocation of Pollution Permits Would Result in No Emissions Reduction Requirement during Early Years of Climate Program." (Oakland, California: Breakthrough Institute), September 23, 2009, http://thebreakthrough.org/blog/2009/09/climate_bill_analysis_part_20.shtml.

18 Michael Shellenberger, "Climate Bill Analysis, Part 11: New UCS Analysis Finds Waxman-Markey RES Won't Increase Clean Energy Deployment," (Oakland, California: Breakthrough Institute) June 10, 2009, http://thebreakthrough.org/blog/2009/06/climate_bill_analysis_part_xi.shtml; Jesse Jenkins, "Climate Bill Analysis, Part 7: Renewable Electricity Standard Severely Weakened; May Have Little to No Impact," (Oakland, California: Breakthrough Institute) May 28, 2009, http://thebreakthrough.org/blog/2009/05/climate_bills_renewable_electr.shtml.

19 See "Barriers to Widespread Clean Energy Adoption and the Public Investment Imperative" in this report.

20 Michael Shellenberger, Ted Nordhaus, Jeff Navin, Teryn Norris, Aden Van Noppen., "Fast, Clean and Cheap: Cutting Global Warming's Gordian Knot," Harvard Law and Policy Review (January 2008) http://thebreakthrough.org/blog/Fast%20Clean%20Cheap.pdf; Michael Grubb, "Technology Innovation and Climate Change Policy, an overview of issues and options." Keio Economic Studies, 41, 2, (2004), 103-132, http://ci.nii.ac.jp/lognavi?name=nels&lang=en&type=pdf&id=ART0002928567; Victor, David, "Making Carbon Markets Work," Scientific American (September 24, 2007), http://www.scientificamerican.com/article.cfm?id=making-carbon-markets-wor.

21 For more on public investments in energy and technology innovation, see: Zachary Arnold, Jesse Jenkins, Ashley Lin (eds.), "Case Studies in American Innovation: a New Look at Government Involvement in Technological Development," (Oakland, California: Breakthrough Institute, April 2009), http://thebreakthrough.org/blog/Case%20Studies%20in%20American%20Innovation.pdf.

22 Zachary Arnold, Jesse Jenkins, Ashley Lin, April 2009.

23 Deutsche Bank analysts project that more direct public policy support and government investment in China and Japan are likely to attract more private investment than the market-based incentives available in the United States, by offering a lower risk environment for investment. Deutsche Bank Climate Change Advisors, October 2009.

24 Keith Bradsher, "China Racing Ahead of U.S. in the Drive to Go Solar," New York Times, (New York, New York), August 24, 2009, http://www.nytimes.com/2009/08/25/business/energy-environment/25solar.html.

25 John A. Alic, David C. Mowery, and Edward S. Rubin, "U.S. Technology and Innovation Policies," (Washington, D.C.: Pew Center on Global Climate Change, 2003), http://www.cleanenergystates.org/library/Reports/Pew_US-Technology_and_Innovation_Policies.pdf.

26 Gregory F. Nemet and Daniel M. Kammen, "U.S. energy research and development: Declining investment, increasing need and the feasibility of expansion," Energy Policy: 35 (2007): 746-755.

27 Joshua Freed, Avi Zevin and Jesse Jenkins, "Jumpstarting a Clean Energy Revolution with a National Institutes of Energy," (Washington, D.C.: Breakthrough Institute and Third Way, September 2009), http://thebreakthrough.org/blog/Jumpstarting_Clean_Energy_Sept_09.pdf.

28 Daniel Sarewitz and Armond Cohen, "Innovation Policy for Climate Change," (Washington, D.C.: Center for Science and Policy Outcomes and Clean Air Task Force, September 2009), http://www.cspo.org/projects/eisbu/report.pdf.

29 For example, the proposed Investments in Manufacturing Progress and Clean Technology Act (IMPACT) would establish a federal revolving loan program, initially capitalized at $30 billion, to provide low-cost loans to assist small and medium-sized firms in retooling, expanding or establishing domestic clean energy manufacturing operations. "Brown Announces New Bill Providing $30 Billion in Funds to Help Auto Suppliers, Manufacturers Retool for Clean Energy Jobs," Sherrod Brown: U.S. Senator for Ohio, June 17, 2009, http://brown.senate.gov/newsroom/press_releases/release/?id=9F3064D8-3F11-4FC5-9E3D-5FE77E102B8C.

30 For example, the American Recovery and Reinvestment Act (ARRA) provided $2.3 billion in tax credits to support private investments in U.S. advanced clean energy manufacturing capacity. Extending the Advanced Energy Manufacturing Tax Credit, or implementing similar incentives, could strengthen the U.S.'s competitive position and build on the short-term incentives established in ARRA. Department of Energy, "Advanced Energy Manufacturing Tax Credit (48C)," Recovery.gov, August 13, 2009, http://www.energy.gov/recovery/48C.htm .

31 For example, the Hollis Manufacturing Extension Partnership (MEP), a program of the National Institutes of Standard and Measures at the U.S. Department of Commerce, provides technical support and services to enhance the growth, improve the competitiveness and expand the capacity of small and medium-sized U.S. manufacturers. The MEP program is well poised to assist American manufacturers establish themselves in clean energy industries and accelerate the adoption of innovative manufacturing processes. Additional funding could be provided for this established and successful program to specifically support clean energy-related manufacturing. "Hollings Manufacturing Extension Partnership," National Institute of Standards and Technology (Washington, D.C.: U.S. Department of Commerce), http://www.mep.nist.gov/.

32 Joshua Freed, Avi Zevin and Jesse Jenkins, September 2009.

33 The United States government has already taken an important step to providing low-cost financing to accelerate emerging technologies with the proposed creation of the Clean Energy Deployment Administration included in legislation passed by the Senate Committee on Energy and Natural Resources (the American Clean Energy Leadership Act of 2009). In order for the proposed new agency to be effective it must be scaled up and fully funded. Senator Jeff Bingaman, "Bingaman on Investments in Clean Energy Technology," (United States Senate Committee on Environment and Natural Resources, July 22, 2009), http://energy.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_id=f85df78d-4766-4455-bbee-c298b360dd5b&Month=7&Year=2009&Party=0.

34 Michael E. Porter, "Clusters and the New Economics of Competition," Harvard Business Review, (1998), http://www.wellbeingcluster.at/magazin/00/artikel/28775/doc/d/porterstudie.pdf.

35 Peter Ford, "How Baoding, China, becomes the world's first carbon-positive city," Christian Science Monitor, (Boston, Massachusetts), August 10, 2009, http://features.csmonitor.com/environment/2009/08/10/how-baoding-china-becomes-world%E2%80%99s-first-%E2%80%98carbon-positive%E2%80%99-city/.

36 Rasmus Reinvang and Liv Inger Tønjum, "Prepared to Ride the Green Dragon?" (Norway: WWF and Innovation Norway, November 2008), 16, http://www.wwf.se/source.php/1215766/Prepared%20to%20Ride%20the%20Green%20Dragon.pdf.

37 Julian L. Wong, "Jiangsu Kicks Off Domestic Solar Market Race with Provincial Subsidies," The Green Leap Forward, April 1, 2009, http://greenleapforward.com/2009/04/01/jiangsu-kicks-off-domestic-solar-market-race-with-provincial-subsidies/.

38 Richard Brubaker, "Tianjin Staging Up for Clean Tech." The Energy Collective, November 13, 2009, http://theenergycollective.com/TheEnergyCollective/51500.

39 "Industrial Cluster Project," (Japan: Ministry of the Economy, Trade and Industry), http://www.cluster.gr.jp/en/index.html .

40 Karen G. Mills, Elisabeth B. Reynolds, and Andrew Reamer, "Clusters and Competitiveness: A New Federal Role For Stimulating Regional Economies," Metropolitan Policy Program, (Washington, D.C.: Brookings Institution, April 2008), http://www.brookings.edu/~/media/Files/rc/papers/2008/04_competitiveness_reamer/Clusters%20Brief.pdf.

41 Karen G. Mills, Elisabeth B. Reynolds, and Andrew Reamer, April 2008.

42 Stephen Ezell, "America and the World: We're No. 40!" Democracy Journal 14, (Fall 2009), http://www.democracyjournal.org/article.php?ID=6703.

43 Michael Shellenberger, Ted Nordhaus, Jeff Navin, Teryn Norris, Aden Van Noppen, January 2008.

44 Karsten Neuhoff, "Large-Scale Deployment of Renewables for Electricity Generation," Oxford Review of Economic Policy 21, 1 (2005). See also: Michael Shellenberger, Ted Nordhaus, Jeff Navin, Teryn Norris, Aden Van Noppen, January 2008.

45 James Duderstadt, Mark Muro, Gary Was, Andrea Sarzynski, Robert McGrath, Michael Corradinim Linda Katehi, and Rick Shangraw, "Energy Discovery-Innovation Institutes: A Step Toward America's Energy Sustainability," Metropolitan Policy Program, (Washington D.C.: Brookings Institution, February 2009), http://www.brookings.edu/reports/2009/0209_energy_innovation_muro.aspx.

46 Joshua Freed, Avi Zevin and Jesse Jenkins, September 2009.

47 Charles Weiss and William Bonvillian, Structuring and Energy Technology Revolution, (Cambridge, Massachusetts: MIT Press, 2009), 129.

48 Charles Weiss and William Bonvillian, 2009, p. 129.

49 Karsten Neuhoff, 2005.

50 Michael Shellenberger, Ted Nordhaus, Jeff Navin, Teryn Norris, Aden Van Noppen, January 2008.

51 Karsten Neuhoff, 2005.

52 Michael Shellenberger, Ted Nordhaus, Jeff Navin, Teryn Norris, Aden Van Noppen, January 2008.

53 A number of independent estimates have projected that the carbon price established under the American Clean Energy and Security Act (ACESA) would remain around $15/ton until as late as 2020. Larry Parker and Brent D. Yacobucci, "Climate Change: Costs and Benefits of the Cap-and-Trade Provisions of H.R. 2454," (Washington, D.C.:Congressional Research Service, September 2009).

54 Michael Shellenberger, Ted Nordhaus, Jeff Navin, Teryn Norris, Aden Van Noppen, January 2008; Karsten Neuhoff, 2005.

55 David Victor and Danny Cullenward, "Making Carbon Markets Work," Scientific American, September 24, 2007.

See also: Nicholas Stern, "Stern Review on The Economics of Climate Change," (Cambridge, United Kingdom: Cambridge University Press, 2007), 308, http://www.hm-treasury.gov.uk/stern_review_report.htm.

56 See for example:

Daniel Sarewitz and Armond Cohen, September 2009.

Joshua Freed, Avi Zevin and Jesse Jenkins, September 2009.

Isabel Galiana and Christopher Green, "An Analysis of a Technology-led Climate Policy as a Response to Climate Change," Copenhagen Climate Consensus, (Denmark: Copenhagen Consensus Center, August 2009).

Charles Weiss and William Bonvillian, 2009.

James Duderstadt, Mark Muro, Gary Was, Andrea Sarzynski, Robert McGrath, Michael Corradinim Linda Katehi, and Rick Shangraw, February 2009.

International Energy Agency, "Energy Technology Perspectives 2008: Scenarios and Strategies to 2050." (Paris, France: IEA, June 2008).

Karsten Neuhoff and Rick Sellers. "Mainstreaming New Renewable Energy Technologies," Cambridge Working Papers on Economics, (Cambridge, United Kingdom: University of Cambridge, March 2006), http://ideas.repec.org/p/cam/camdae/0624.html.

Karsten Neuhoff, 2005.

Michael Grubb, 2004.

For others, see Ted Nordhaus, Michael Shellenberger, Jeff Navin, Teryn Norris, Aden Van Noppen, "The Investment Consensus." (Oakland, California: Breakthrough Institute 2007), http://thebreakthrough.org/blog/Investment%20Consensus.pdf.

57 Joshua Freed, Avi Zevin and Jesse Jenkins, September 2009

58 Karsten Neuhoff, 2005.

59 Karsten Neuhoff, 2005.

"Competing Industries" Sections

60 Valerie J. Karplus, "Innovation in China's Energy Sector," Working Paper #61, (Palo Alto, California: Stanford University Program on Energy and Sustainable Development, March 2007), http://iis-db.stanford.edu/pubs/21519/WP61__Karplus_China__Innovations.pdf.

61 Mark National Basic Research Program of China, "Profile of 973 Program," (China: Government of China, 2009), http://www.973.gov.cn/English/Index.aspx.

62 "Recommendations for Improving the Effectiveness of Renewable Energy Policies in China," (Ren21, October 2009), http://www.ren21.net/pdf/Recommendations_for_RE_Policies_in_China.pdf.

63 Valerie J. Karplus, March 2007.

64 Qi Huang Qili, Li Junfeng, and Gao Hu, "Study of the Development Road Map of China's Renewable Energy," Engineering Sciences 7, 2, (June 2009), http://qk.nbdl.gov.cn/JourDetail.jsp?dxNumber=100180022450&d=D61C7D5D52D996746060629A6FB9B08B.

65 "China to step up solar energy R&D." China Daily, January 26, 2009, http://www.chinadaily.net/bizchina/2009-01/26/content_7429022.htm.

66 Yingling Liu, "Brain Gain in China's Solar Cell Sector," ChinaWatch, (Washington, D.C.: Worldwatch Institute, December 22, 2005) , http://www.worldwatch.org/node/3868.

67 Aaron Hand, "Suntech Breaks Efficiency Record for Multicrystalline Solar Module," PVSociety.com, August 19, 2009, http://www.pvsociety.com/article/328051-Suntech_Breaks_Efficiency_Record_for_Multicrystalline_Solar_Module.php.

68 Thomas L. Friedman, "Have a Nice Day," New York Times, (New York, New York) September 15, 2009, http://www.nytimes.com/2009/09/16/opinion/16friedman.html.

69 Zhang Xiang, "China Eyes Independent Nuclear Power Development," China View, (China: Xinhua News Agency), February 18, 2009, http://news.xinhuanet.com/english/2009-02/18/content_10842954.htm.

70 World Nuclear Association, "Nuclear Power in China," (London, United Kingdom: WNA, 2009), http://www.world-nuclear.org/info/default.aspx?id=320&terms=China.

71 Near Zero Emissions Coal (NZEC) official site, "What Is NZEC?" http://www.nzec.info/en/what-is-nzec/.

72 U.S. Department of Energy, "US-China Clean Energy Research Center Announced," (Washington, D.C.: DOE, July 15, 2009), http://www.energy.gov/news2009/7640.htm.

73 International Energy Agency, "R&D Database," IEA Energy Technology R&D Statistics Service, (Paris, France: IEA), http://www.iea.org/textbase/stats/rd.asp.

74 Council of Science and Technology Policy, "Low Carbon Technology Plan," (Japan: Government of Japan, May 19, 2009), http://www8.cao.go.jp/cstp/english/doc/low_carbon_tec_plan/ref_roadmap1.pdf.

75 Ministry of Economy, Trade, and Industry, "Cool Earth-Innovative Technology Program," Government of Japan, March 2008), http://www.meti.go.jp/english/newtopics/data/pdf/031320CoolEarth.pdf.

76 New Energy and Industrial Technology Development Organization, "Mission and Policies," (Japan: NEDO, 2009), http://www.nedo.go.jp/english/introducing/mis_poli.html.

77 "Environment & Energy Technology Roadmap and Diffusion Scenario," (Japan: Government of Japan), www8.cao.go.jp/cstp/english/doc/low_carbon.../ref_roadmap1.pdf.

78 Council of Science and Technology Policy, "Low Carbon Technology Plan," (Japan: Government of Japan, May 19, 2009), http://www8.cao.go.jp/cstp/english/doc/low_carbon_tec_plan/ref_roadmap1.pdf.

79 OECD Directorate for Science, Technology and Industry, "Compendium of Patent Statistics, 2008," (Paris, France: Organisation for Economic Co-operation and Development, 2008), 20, http://www.oecd.org/sti/ipr-statistics.

80 "Clean Energy Patent Growth Index," (Albany, New York: Cleantech Group - Rothenberg Farley & Mesiti P.C., 2009), http://cepgi.typepad.com/.

81 Cleantech Group, 2009.

82 Korea Energy Management Corporation, "R&D: New & Renewable Energy," (Korea: KEMCO, 2009), http://www.kemco.or.kr/web/kcms/main/kcms.asp?c=PAGEML000000721.

83 For a detailed examination of South Korea's energy technology roadmapping, see: Seong Kon Lee, Gento Mogi, and Jong Wook Kim, "Energy Technology Roadmap for the Next 10 years: the Case of Korea," Energy Policy 37, 2, (February 2009).

84 International Energy Agency, "R&D Database."

85 Daniel Castro, "Learning from the Korean Green IT Strategy," (Washington, D.C.: Information Technology and Innovation Foundation, August 2009), http://www.itif.org/files/WM-2009-02-GreenIT.pdf.

86 OECD Directorate for Science, Technology and Industry, 2008, p. 20.

87 Cleantech Group, 2009.

88 OECD Directorate for Science, Technology and Industry, 2008, p. 20.

450 Jesse Jenkins, "Climate Bill Analysis, Part 10, Smart Provisions Could Spur Clean Technology—If They Are Funded," (Oakland, California: Breakthrough Institute, June 5, 2009), http://thebreakthrough.org/blog/2009/06/climate_bill_analysis_part_x_s.shtml.

451 See Appendix A of this report.

452 Michael Graham Richard, "Obama Announces $2.4 billion in Grants for Batteries and Electric Cars," Treehugger.com, August 5, 2009, http://www.treehugger.com/files/2009/08/obama-announces-money-for-battery-and-electric-cars.php.

453 "Obama unveils high-speed passenger rail plan," CNN, (Washington D.C.), April 16, 2009, http://www.cnn.com/2009/POLITICS/04/16/obama.rail/.

Sujit M. CanagaRetna, "High-Speed Rail: Update from the Southern States," (Atlanta, Georgia: Southern Legislative Conference of the Council of State Governments, July 2009), http://www.slcatlanta.org/Publications/EconDev/High_Speed_Rail.pdf.

454 Suzanne Goldenberg, "High-speed rail in the United States: Back on track after 50 years of neglect," The Guardian, (London, UK), August 5, 2009, http://www.guardian.co.uk/world/2009/aug/05/high-speed-rail-united-states.

455 "Senate Passes FY 2010 Transportation, Housing and Urban Development Appropriations Bill," (Washington D.C.: U.S. Senate Committee on Appropriations, September 17, 2009), http://appropriations.senate.gov/news.cfm?method=news.view&id=8ad06395-6852-4991-a375-b4d56c85e9e1.

456 Deborah Hastings, "Billions for high-speed rail; anyone aboard?" Associated Press, (Washington D.C.), March 26, 2009, http://news.yahoo.com/s/ap_travel/20090326/ap_tr_ge/travel_brief_fast_trains.

457 Joan Lowy, "High Speed Rail Advocates Say $8 billion is Just a Start, " The Seattle Times, (Washington D.C.), October 23, 2009, http://seattletimes.nwsource.com/html/nationworld/2010121374_apusstimulushighspeedrail.html.

458 Michael Dresser, "Others leave U.S. in the dust on high-speed rail," Baltimore Sun, (Baltimore, Maryland), October 26, 2009, http://www.baltimoresun.com/features/commuting/bal-md.dresser26oct26,0,5889398.story.

459 Deborah Hastings, March 26, 2009.

460 Sujit M. CanagaRetna. "High-Speed Rail: Update from the Southern States." (Southern Legislative Conference of the Council of State Governments, July 2009), http://www.slcatlanta.org/Publications/EconDev/High_Speed_Rail.pdf.

461 "California High-speed Rail Network, USA." Railway-technology.com http://www.railway-technology.com/projects/california/.

462 White House Press Release, "President Obama Announces $3.4 Billion Investment to Spur Transition to Smart Energy Grid," (Washington D.C.: White House, October 27, 2009), http://www.whitehouse.gov/the-press-office/president-obama-announces-34-billion-investment-spur-transition-smart-energy-grid.

Conclusions and Appendices

463 John Alic et al, "U.S. Technology and Innovation Policies," (Arlington Virginia: Pew Center on Global Climate Change, November 2003), http://www.cleanenergystates.org/library/Reports/Pew_US-Technology_and_Innovation_Policies.pdf.

464 Gregory F. Nemet and Daniel M. Kammen, "U.S. energy research and development: Declining investment, increasing need and the feasibility of expansion," Energy Policy, 35 (2007), www.iaee.org/en/students/best_papers/Gregory_Nemet.pdf.

465 Josh Freed, Avi Zevin and Jesse Jenkins, "Jumpstarting a Clean Energy Revolution with a National Institutes of Energy," (Washington D.C.: Breakthrough Institute and Third Way, September 2009), http://thebreakthrough.org/blog/Jumpstarting_Clean_Energy_Sept_09.pdf.

466 Daniel Sarewitz et al, "Innovation Policy for Climate Change," (Washington D.C.: Center for Science and Policy Outcomes and Clean Air Task Force, September 2009), http://www.cspo.org/projects/eisbu/report.pdf.

467 For example, the proposed Investments in Manufacturing Progress and Clean Technology Act (IMPACT) would establish a federal revolving loan program, initially capitalized at $30 billion, to provide low-cost loans to assist small and medium-sized firms in retooling, expanding or establishing domestic clean energy manufacturing operations.

See: Press Release, "Brown Announces New Bill Providing $30 Billion in Funds to Help Auto Suppliers, Manufacturers Retool for Clean Energy Jobs," (Washington D.C.: Office of U.S. Senator Sherrod Brow, June 17, 2009), http://brown.senate.gov/newsroom/press_releases/release/?id=9F3064D8-3F11-4FC5-9E3D-5FE77E102B8C

468 For example, the American Recovery and Reinvestment Act (ARRA) provided $2.3 billion in tax credits to support private investments in U.S. advanced clean energy manufacturing capacity. Extending the Advanced Energy Manufacturing Tax Credit, or implementing similar incentives, could strengthen the U.S.'s competitive position and build on the short-term incentives established in ARRA.

See: U.S. Department of Energy, "Advanced Energy Manufacturing Tax Credit (48C)," (Washington D.C.: U.S. Department of Energy, August 13, 2009), http://www.energy.gov/recovery/48C.htm.

469 For example, the Hollis Manufacturing Extension Partnership (MEP), a program of the National Institutes of Standard and Measures at the U.S. Department of Commerce, provides technical support and services to enhance the growth, improve the competitiveness and expand the capacity of small and medium-sized U.S. manufacturers. The MEP program is well poised to assist American manufacturers establish themselves in clean energy industries and accelerate the adoption of innovative manufacturing processes. Additional funding could be provided for this established and successful program to specifically support clean energy-related manufacturing.

See: National Institute of Standards and Technology, "Hollings Manufacturing Extension Partnership," (Gaithersberg, Maryland: National Institute of Standards and Technology, Accessed October 2009), http://www.mep.nist.gov/.

470 Josh Freed, Avi Zevin and Jesse Jenkins, September 2009.

471 The United States government has already taken an important step to providing low-cost financing to accelerate emerging technologies with the proposed creation of the Clean Energy Deployment Administration included in legislation passed by the Senate Committee on Energy and Natural Resources (the American Clean Energy Leadership Act of 2009). In order for the proposed new agency to be effective it must be scaled up and fully funded. Senator Jeff Bingaman, "Bingaman on Investments in Clean Energy Technology," (United States Senate Committee on Environment and Natural Resources, July 22, 2009), http://energy.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_id=f85df78d-4766-4455-bbee-c298b360dd5b&Month=7&Year=2009&Party=0.

472 Clean Energy States Alliance, "State Renewable Energy Fund Support for Renewable Energy Projects,"(Montpelier,Vermont: CESA, January, 2009) www.cleanenergystates.org/Publications/cesa-database_summary_v8.pdf

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