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Commissioner Bartholomew, Commissioner Brookes, and members of the Commission, thank you for the opportunity to testify today.

My name is Devon Swezey, and I am Project Director at the Breakthrough Institute, a climate and energy policy think tank based in Oakland, CA. Since it's founding in 2004, the Breakthrough Institute has advanced an innovation and investment-centered policy framework for addressing climate change, energy security, and U.S. economic competitiveness in clean energy.

It is my great pleasure to discuss with you China's comprehensive strategy for developing a domestic clean energy economy, and the various policies and investments that the United States must prioritize to mount an effective response to the competitiveness challenges it faces today.

As the United States searches for new sources of economic growth and domestic job creation in the midst of a sluggish economic recovery, the rapidly growing clean energy industry represents an important job creation and export market opportunity. Global private investment in renewable energy and energy efficient technologies is estimated to reach $450 billion annually by 2012 and $600 billion by 2020.[i]

Unfortunately, the United States' competitive position in clean energy production has declined markedly in the last decade. Whereas the United States produced 40 percent of the world's solar cells a decade ago, today that figure is 5 percent. The United States relies on foreign-owned companies to manufacture the majority of its wind turbines and is losing ground on hybrid and electric vehicle technology and manufacturing.[ii] Measured by market capitalization, only four of the world's top 30 solar, wind, and advanced battery companies are American.[iii] With no domestic manufacturers of high-speed rail technology, the United States will rely on companies in China or other foreign countries to provide rolling stock for any planned high-speed rail lines.

At the same time, other nations, and particularly China, are moving quickly to implement comprehensive clean energy investment strategies, which will allow them to gain first-mover advantages ahead of the United States and capture a

majority of the economic benefits—in terms of jobs, tax revenues, and greater growth—associated with this burgeoning industry.

China in particular has emerged as a clean energy manufacturing powerhouse. With over 400 solar PV companies, China is now the world's largest solar manufacturer and has one-third of global solar manufacturing capacity, a share that is destined to grow.[iv] Last year, China became the top manufacturer of wind turbines in the world.[v] China has also taken the lead in commercializing plug-in hybrid and electric vehicles, and in manufacturing the advanced batteries that will power them. By 2008, China's production of lithium ion batteries had accounted for 41 percent of the global market.[vi] China is also developing an indigenous nuclear reactor technology and plans a massive build-out of new nuclear power plants over the next two decades.

With clean energy manufacturing increasingly shifting abroad, it's little surprise that the U.S. is running a clean energy trade deficit. According to the office of U.S. Senator Ron Wyden, the U.S. trade deficit in renewable energy goods has ballooned to nearly $6 billion in 2008, an increase of 1,400% from five years before.[vii] Should this gap continue to grow, the United States risks importing the majority of clean energy technologies necessary to meet domestic demand.

What is perhaps even more concerning is that as clean energy manufacturing has shifted overseas, particularly to Asia, research and innovation activities—the area that has historically been America's "comparative advantage"—have started to follow. Perhaps the most high-profile example is Silicon Valley giant Applied Materials, the world's biggest manufacturer of equipment used to make solar cells, which recently decided to construct the world's largest, most advanced nongovernmental solar energy research and development facility in Xian, China. Among the reasons cited by Applied Materials was that China, not the U.S., "would be the biggest solar market in the world."[viii]

Applied Materials is not alone. IBM has announced that it will invest $40 million to create the company's first "energy-and-utilities-solution lab" to develop innovative new technologies for smart grid and other applications. The new lab will also be located in China. These high-tech firms' decisions follow those of leading U.S. companies such as GM, Dow Chemical, and Intel, which have all constructed high-tech research labs in China, and show that high-value R&D is starting to follow manufacturing abroad, threatening America's traditional global leadership in innovation.

U.S. Risks Losing Out on Clean Energy Opportunity

The race is on to attract growing investments in the clean energy industry, and the U.S. is behind. In November 2009, the Breakthrough Institute and the Information Technology and Innovation Foundation (ITIF) published "Rising Tigers, Sleeping Giant," which documented that the United States lags China, Japan, and South Korea

in the production of virtually all clean energy technologies.[ix] To make matters worse, over the next five years we projected that these three nations will out-invest the United States in clean energy technologies by a margin of three to one. China, Japan, and South Korea will invest $509 billion in clean energy from 2009-2013, while the United States would invest $172 billion over the same period, a sum that assumes passage of the House-passed American Clean Energy Security Act (ACESA).[x]

The largest investment are expected to come from China, which is reported to be planning new investments of at least $440 billion over ten years.[xi] These investments are expected to focus heavily on low-carbon power technologies, and are in addition to the billions of dollars China has already invested in clean energy as part of its economic stimulus package.

While the United States has historically attracted the bulk of available private investment in clean energy, capital flows are increasingly being directed to Asia's "clean tech tigers," and these nations' greater public investments are likely to attract much of the future follow-on private investment in clean energy technologies.

For the first time in 2008, China attracted more private investment in clean energy than the United States, according to Deutsche Bank, and China's share of global clean tech investment is rising each year.[xii] In 2009, China attracted the most private clean energy investment than any nation in the world, with $34.6 billion, nearly twice the $18.6 billion invested in the United States.[xiii]

China is not out-competing the United States in the clean energy industry because of some inherent comparative advantage, but through targeted and comprehensive government policies to stimulate the growth of new clean energy industries. This policy is characterized first and foremost by major public investment.

China's Comprehensive Clean Energy Strategy

China's comprehensive policy begins with ambitious targets for clean energy deployment. In 2007, the National Development and Reform Commission (NDRC) created a "Medium and Long-Term Development Plan for Renewable Energy," which raised the nation's renewable energy target to 10 percent by 2010 and 15 percent by 2020. It also established technology-specific targets for renewable energy, including targets of 30GW of wind power, 300 GW of hydropower, and 1.8 GW of solar PV by 2020. China also developed a "Medium and Long-Term Development Plan for Nuclear Power," which called for a major acceleration in domestic nuclear power development and deployment and set a target for 40 GW of installed capacity by 2020.[xiv]

As a result of the rapid development of many of China's clean energy technology industries, government officials have officially revised these earlier targets. The government more than tripled its wind energy target to 100GW by 2020 and is

considering increasing it even further to 150 GW. The government has officially increased its 2020 solar PV target more than ten times, to 20GW. In April 2010, the Chinese Nuclear Energy Association projected that China would deploy 80 GW of nuclear power by 2020—double the target established in 2007—and an astounding 200 GW of Nuclear power capacity by 2030.

These ambitious national clean energy targets are backed up by major public investments and targeted incentives for clean energy R&D, manufacturing, market creation, and infrastructure.

China is rapidly developing its domestic capacity for indigenous innovation, and has targeted clean energy as a priority R&D sector. Over all sectors of the economy, China's investments in R&D grew by over 20% annually between 1996 and 2007. In January of this year, China's National Energy Bureau announced the licensing of 16 national energy R&D centers to develop wind, nuclear, and other technologies.[xv]

The rapid expansion of domestic clean energy manufacturing capacity has been facilitated in part by shielding domestic component manufacturers from international competition, and giving preference to Chinese firms to fill government contracts. Until recently, the Chinese government mandated that 70 percent of the equipment needed for installed wind power plants must be sourced domestically. By 2007, these policies led to the creation of over 50 domestic wind power technology companies, and China now controls over 60 percent of the domestic market, historically dominated by imports. China's defense industry has also been directed to assist domestic firms in advancing the wind power equipment industry and developing a complete supply chain.

China's clean energy manufacturing industry has also benefited from targeted government incentives to boost domestic demand. The deployment of wind turbines has been boosted by variable feed-in tariffs for wind-generated electricity, mandated market shares for renewable energy, and value-added tax rebates. As a result of this support for the domestic industry, China's installed annual capacity has doubled in each of the last five years, and in 2009 China installed a world-leading 13 GW of new capacity. En route to its goal of deploying 150 GW of wind turbines by 2020, the government is planning seven wind power "mega projects" with a minimum capacity of 10 GW each.[xvi]

While China has traditionally exported the large majority—over 95 percent—of its solar PV output, the government has announced initiatives to incentivize and support the development of a domestic solar energy industry. One such initiative is the "Golden Sun" program, which subsidizes as much as 50 percent of the investment cost for grid-connected solar systems. The government is also considering implementing a feed-in tariff for solar power.

China is also supporting the development of its clean energy industries by making major investments in enabling infrastructure. In 2008, more than 20 percent of

Chinese wind turbines did not generate electricity because they were not yet connected to the grid.[xvii] In order to ensure the effective operation of new renewable energy projects, China is investing $161 billion over three years on grid infrastructure such as expanding power lines and building out transmission[xviii]. China is already a leader in ultra high voltage (UHV) transmission technology, and China's State Grid Corporation will invest $44 billion in UHV power lines through 2012. To supplement procurement policies and further support the development of the plug-in hybrid and electric vehicle industry, the government is also setting regulations to develop electric vehicle charging infrastructure.

Lastly, local and provincial governments in China are accelerating the pace of innovation throughout the domestic clean energy industry by creating clean energy clusters—dense regional networks of inventors, investors, manufacturers, suppliers, universities, local government officials and other actors that can confer a lasting competitive advantage to the region as a whole. Governments in China are offering clean energy companies generous subsidies to establish operations in their localities, including free land, low-cost financing, tax incentives, and money for R&D. One prime example is the city of Baoding, which has transformed from an automobile and textile town into the fastest growing hub of wind solar energy equipment makers in China. The city is home to "Electricity Valley," an industry cluster modeled after Silicon Valley, composed of nearly 200 renewable energy companies focusing on wind power, solar PV, solar thermal, biomass and other technologies.[xix]

Current and Proposed U.S. Policies are Not Enough to Stay Competitive

With China and other nations moving aggressively to capture market share in the growing clean energy industry, current U.S. energy and climate policies are insufficient to keep the United States competitive.

The American Recovery and Reinvestment Act (ARRA) stimulus legislation directed major investments to clean energy and energy efficiency technologies, including public investments totaling $62 billion as well as further clean energy tax credits and incentives valued at roughly $20 billion over the next 10 years.[xx] While it was hastily constructed and not necessarily optimized, ARRA represents the beginnings of a strategy that invests across most of the critical areas needed to create a robust clean energy economy, including research and innovation, advanced technology manufacturing, clean energy deployment and infrastructure. These investments are already paying off, and are attracting substantial follow-on private investment that is creating thousands of jobs.[xxi]

But the temporary stimulus investments are set to expire and funding will be cut across all areas of America's incipient clean tech industry. Worse yet, proposed legislation won't be enough to fill the gap. If the stimulus is not replaced with and equally effective clean energy competitiveness strategy that continues and

optimizes these critical investments, it may only precipitate a new boom-bust cycle in the U.S. economy, fizzling just as the clean energy race heats up.

Unfortunately, neither the House-passed American Clean Energy and Security Act (ACESA) nor the Kerry-Lieberman American Power Act (APA) will be sufficient to keep the United States competitive with China.

Both bills would create a nation-wide cap and trade program to establish a price on carbon dioxide emissions and other greenhouse gases, a measure intended to incentivize adoption of clean and efficient energy technologies. However, due to a number of measures in the bills to contain the cost of compliance with the cap and trade program (most notably the permitted use of offsets to cover up to two billion tons of emissions annually), the carbon price established by both bills is expected to be relatively low.[xxii]

According to the EPA, a carbon price in this range is not likely to significantly increase demand for clean energy technologies in the near-term, especially for technologies that remain much more expensive than fossil fuels. It's not difficult to see why. The effective subsidy rate of the ACESA carbon price is 0.8-1.5 cents/kWh, less than even the U.S. wind energy production tax credit (2.1 cents/kWh) or the Chinese feed-in tariff for wind energy (2-4 cents/kWh), which have helped spur the deployment of wind energy. To the extent that independent analysts have projected increases in renewable energy deployment over the next 10 years under both ACESA and APA, it is as a result of the direct investments in the U.S. stimulus bill or existing incentives like the wind energy production tax credit (PTC), not as a result of a low carbon price.[xxiii]

A further problem with both the House and Senate bills is that they focus on demand side regulations and not enough on technology supply. Yet without a policy focused on the supply-side (i.e. U.S. manufacturing and innovation), any policies to spur demand for clean energy will simply result in demand being filled by foreign technologies.

A Comprehensive Clean Energy Strategy for America

In the face of aggressive foreign competition in the clean energy industry, the United States urgently needs a comprehensive clean economy strategy of its own to accelerate the development of a domestic clean energy industry and take advantage of emerging export opportunities.

For too long, U.S. policymakers have assumed that funding some basic research, and providing a few small incentives for the deployment of wind turbines, solar panels, and other technologies, would be enough to build a clean energy economy. But today it is clear that this is a losing strategy, as nations in Asia and Europe continue to out-pace the United States with comprehensive and targeted clean energy investment strategies.

To compete, the United States needs an investment strategy of its own, which, like those of many competitors, prioritizes large and sustained public investments in research and innovation, manufacturing, market creation, education and cluster formation.

The United States doesn't have to look far for examples of past public investment strategies that developed whole new industries, unleashed waves of economic prosperity, and made the United States the world's pre-eminent technological leader. Indeed, public sector investments in new technologies have traditionally played a pivotal role in supporting emerging industries and catalyzing further private sector investment. 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.

Today, clean energy remains too expensive relative to fossil fuels to be widely deployed at scale, particularly in the developing world, where the large majority of future electricity demand will occur. Further, most nations are unable or unwilling to enact high carbon prices or permanent ongoing subsidies to make clean energy competitive. Therefore, the overarching goal of any national clean energy strategy should be to *make clean energy cheap* in real, unsubsidized terms. Such a strategy should prioritize sustained public investment and support for at least five critical areas: research and innovation, advanced manufacturing, market creation, education, and industry cluster development.

First, there is strong expert consensus around the need to dramatically boost public investment in **energy R&D** by at least $15 billion per year in order to invent new breakthrough technologies, and improve existing clean energy technologies and reduce their costs.[xxiv]

A scale-up in federal investment for energy R&D should be directed to both existing science and technology agencies—such as the Department of Energy's (DOE) Office of Science, the National Science Foundation (NSF), and the National Institutes of Standards and Technology (NIST)—as well as new innovative programs within these agencies to make them more effective in energy innovation. The United States should also create a new National Institutes of Energy (NIE) to most efficiently prioritize the development of commercially deployable and cost-competitive energy technologies.

Three new federal energy R&D programs offer new institutional models for supporting energy research at different stages in the technology pipeline, and should be fully supported by Congress as part of any successful clean energy competitiveness strategy: DOE's Energy Frontier Research Centers (EFRCs), the

Advanced Research Projects Agency for Energy (ARPA-E), and eight proposed Energy Innovation Hubs. EFRCs fund small, collaborative groups of researchers working to unlock breakthroughs that solve the specific scientific problems blocking clean energy development. ARPA-E funds researchers in the public or private sector focused on high-risk, high-reward breakthroughs in energy technology, and is modeled after the Defense Advanced Research Projects Agency (DARPA), which drove rapid technological innovation and invented technologies in ubiquitous use today, including the Internet and GPS. DOE Innovation Hubs are large, collaborative teams of scientists and engineers that work together over a longer time frame to achieve goals for specific topics, such as dramatically cheaper solar energy.

Crucially, the United States also lacks a national energy innovation institution. The Department of Energy was not intended to prioritize the types of innovation that will lead to new commercial energy technologies and the department continues be more focused on managing the nation's sprawling nuclear weapons arsenal. Therefore, the federal government should create a new National Institutes of Energy (NIE) to absorb a needed increase in energy R&D funding and coordinate investments among a network of regional energy institutes designed to integrate fundamental scientific discoveries with applied innovations and work closely with industry, entrepreneurs and the investment community to rapidly develop clean energy technologies and transfer them to the marketplace.[xxv]

Second, Congress should provide more support for **domestic clean energy manufacturers**, and adopt an explicit manufacturing agenda. The U.S. government has consistently lacked a set of policies to help clean energy manufacturers scale up, reduce costs, and stay at the cutting edge. Manufacturing is a traditional engine of wealth creation and job growth, and a key part of the nation's innovation ecosystem. As high-tech manufacturing moves abroad we risk losing our capacity to innovate.

The Breakthrough Institute, Information Technology and Innovation Foundation (ITIF), and the Brookings Institution have proposed a number of measures to support clean energy manufacturing, including increasing funding for the Department of Commerce's Manufacturing Extension Partnership (MEP) and creating a new regional clean energy supply chain initiative through MEP to support manufacturers in their diversification into clean energy markets; creating a $15 billion, state-managed revolving loan fund to provide access to low-cost financing for advanced clean energy manufacturers to retool or expand clean energy production facilities and adopt advanced clean energy production techniques; creating a Federally Funded R&D Center to invest in manufacturing process R&D to improve industrial competitiveness and make manufacturers more efficient; and extending the 48C advance energy manufacturing tax credit, first enacted in the stimulus, which has increased the number of clean energy manufacturing facilities in the United States.[xxvi]

Third, the U.S. must create a **long-term, stable domestic demand** for clean energy technologies. Clean energy manufacturers are unlikely to locate or remain in the

United States without this market certainty. Carbon pricing can play a role here, but any established carbon price will likely be too low to encourage much greater demand for all but the lowest-cost and most mature energy technologies. The government must rethink the way that it structures its clean energy deployment policies. Currently, policies like the wind energy production tax credit (PTC) are designed simply to drive more wind turbines into the ground. Rather, we need a set of policies that treat deployment as part of the innovation process and rationalize deployment around reducing the real costs of clean energy technologies. One proposed institution, the Clean Energy Deployment Administration (CEDA), would help achieve this goal, and has explicit technology and cost improvement goals as part of its mission. Ultimately, however, the government's role should also extend beyond financing to direct deployment or procurement to accelerate cost reductions in new technologies.

Fourth, the United States must **inspire and train a new generation of scientists and engineers** and equip them with the tools necessary to address our long-term energy, climate, and economic challenges. U.S. students consistently trail their peers in leading science and math education indicators. Securing long-term economic competitiveness will require major new investments in our energy workforce as clean energy emerges as one of the most promising economic opportunities of our time.

Congress should support programs like the joint DOE-NSF RE-ENERGYSE initiative, which would provide $74 million to support interdisciplinary energy curriculum development and provide resources for graduate students and postdoctoral researchers involved in the frontiers of energy research.[xxvii] While RE-ENERGYSE is a critical first step, a much larger national education investment program will ultimately be necessary to ensure the availability of the trained and highly skilled workforce needed to accelerate clean energy innovation and secure America's clean energy competitiveness. Breakthrough, Brookings, and ITIF have recommended a program scaling over the next five years to $470 annually to fund curriculum development for energy science disciplines; financial aid and scholarships for undergraduate students entering science, technology, engineering and math (STEM) fields; graduate fellowships for energy engineering, science and related research fields; and post-doctorate research awards for early-career researchers.

Lastly, the government should facilitate the development of regional clean energy clusters to link and align existing assets at the regional level and accelerate clean energy innovation, production, and commercialization. Regional industry clusters are functional "innovation ecosystems" within which inventors, investors, manufacturers, suppliers, and universities, as well as local and state government officials interact and may establish dense, productive networks of relationships. We have recommended that Congress authorize a new grant program to support regional clean energy industry cluster initiatives.[xxviii]

America can still be the world leader in the global clean tech industry. We remain one of the most innovative and entrepreneurial countries in the world. But without a comprehensive clean energy competitiveness strategy that can compete with those implemented around the world, America will lose out on one of the greatest economic opportunities of the 21st century.

Notes

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[x] ibid.

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[xiii] Pew Charitable Trusts, "Who's Winning the Clean Energy Race?'' March 2010, http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Global_warming/G-20%20Report.pdf

[xiv] For more on China's comprehensive strategy, see "Rising Tigers Sleeping Giant,"

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[xx] Breakthrough Institute. "Detailed Summary of Energy Investments in Stimulus." February 13, 2009. http://www.thebreakthrough.org/blog/2009/02/full_summary_of_energy_investm.shtml
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