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China and Clean Energy

Testimony of

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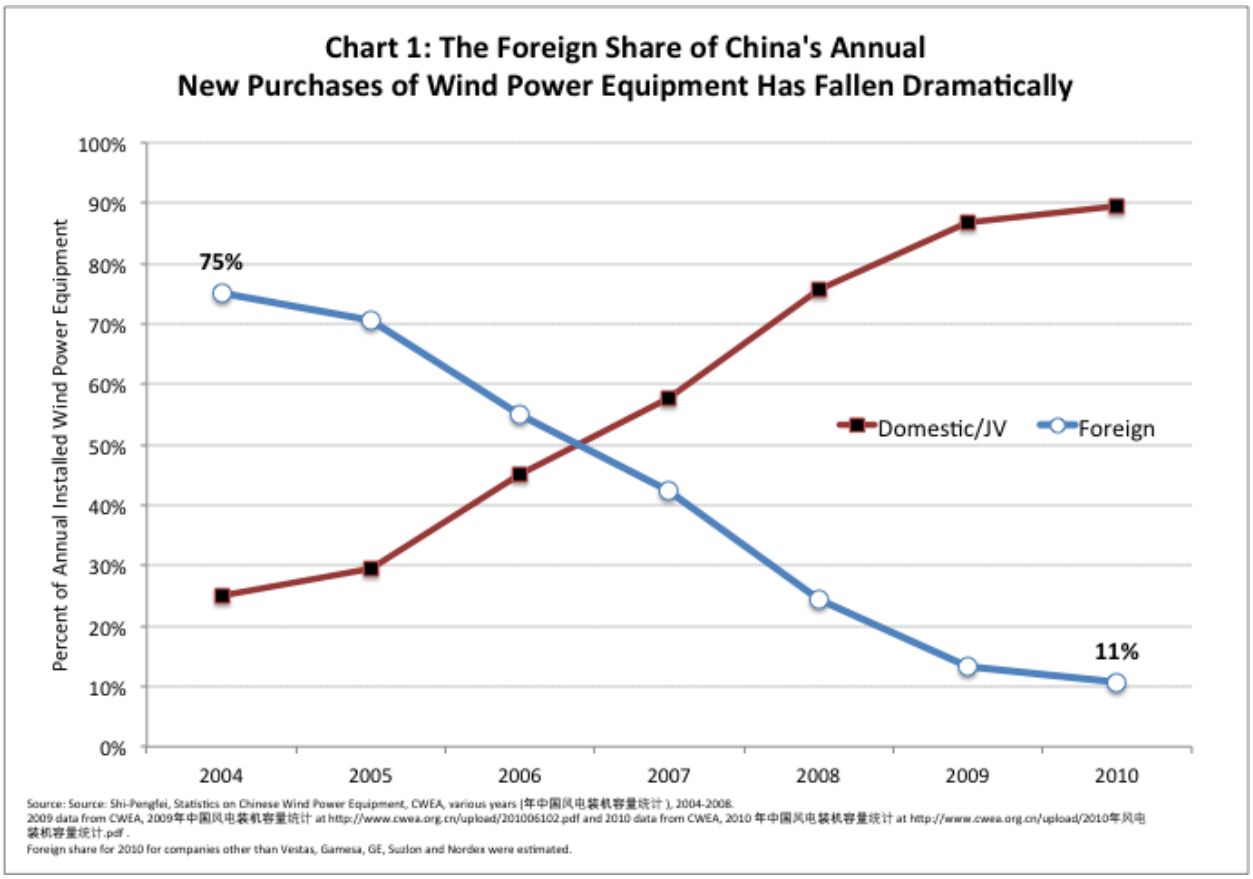
Mr. Chairman, members of the Committee, the subject of your hearing today concerns one of the most important challenges facing America today – our country's future in clean energy.

During 2011, fourteen solar energy companies announced plans to scale back or cease U.S. production, five were in bankruptcy or insolvency. Although the picture is mixed[1] a substantial number of others are in serious financial difficulties. In wind power, foreign wind turbine producers share of the Chinese market dropped from 75% in 2004 to 11% in 2010. See Chart 1. There are clear limits to the degree to which the U.S. market can be served with hydro power (even taking into account additional hydro power from Canada) and biofuels have not yet reached a stage where they can play a major role in the near-term expansion of electric power derived from renewables. Solar and wind must form an increasing part of the future source of U.S. energy needs, and the American industries producing the equipment needed to generate these forms of energy are under siege.

There are a number of causes of the current problem. The welcome discovery of large untapped volumes of commercially accessible natural gas has had and will continue to have a major near term depressing effect on the development of renewable energy even when a new equilibrium price for natural gas is established. But there is a second major factor affecting U.S. productive capacity in this sector that is less welcome, and that is the entry of China as a key producer of renewable energy equipment because its industrial policies are re-shaping an important segment of the U.S. economy. Global overcapacity, and particularly overcapacity in

[1] In March, 2012, Stion, a manufacturer of high-efficiency thin-film solar modules, began to ship modules produced at its Hattiesburg, Ms., factory.

China in polysilicon PV manufacturing, is having a worldwide depressing effect on the PV manufacturing industry.[2] Market barriers to wind energy equipment are equally troubling.



I have spent the better part of my professional life analyzing and dealing with competitive challenges to U.S. industries. As trade counsel to the U.S. Semiconductor Industry Association (SIA), I was actively involved in the U.S. industry's efforts to survive and become fully competitive when Japanese industrial policy threatened to eliminate our industry. More recently, I have been actively engaged in the work of the Science Technology and Economic Policy (STEP) Board of the National Academies. I chair the Board's Committee on Comparative Innovation Policies, which will soon publish its final report entitled *Rising to the Challenge: U.S. Innovation Policy for the Global Economy*. I also chair the Board of the National Foreign Trade Council (NFTC) which published a study in 2010 that I co-authored entitled *China's Promotion of the Renewable Electric Power Equipment Industry -- Hydro, Wind, Solar, Biomass.*[3] I am, however, appearing today in an individual capacity and not speaking for any client or institution.

[2] Asian producers are as a result scaling back.

[3] http://www.nftc.org/default/Press%20Release/2010/China%20Renewable%20Energy.pdf

You have posed three questions.

- What is the current landscape of Chinese investment in clean and renewable energy?
- How do we promote U.S. competitiveness with China in the clean tech sector?
- What are the appropriate U.S.-Chinese relationships on clean energy?

In my oral remarks, I will, as you have requested, concentrate on addressing questions #2 and #3.

The current landscape of Chinese investment in clean and renewable energy.

China leads the world in installed clean energy capacity as of 2011[4]. See Table 1 and Chart 2. This is the result of many years of government mandates and subsidies. The 2002 Government Procurement Law required government entities to purchase domestic products, which was one spur to China's development of the equipment needed to achieve its renewable energy goals. Wind farms were required to meet a 70% local content requirement.[5] The 2006 Renewable Energy Law required utilities to pay full price for electricity generated by renewable energy sources, and gave discounted rates to consumers. Indigenous innovation requirements introduced in 2006 reinforced the buy-domestic, buy-Chinese requirements throughout China's state-owned sector. In 2007, the Medium and Long-Term Development Plan for Renewable Energy in China set clean energy standards estimated to require non-hydro renewable energy installed power capacity of 3% by 2010 and 8% by 2010, causing investment in the renewables sector to surge. China's stimulus package emphasized renewable energy projects.[6] China continues to maintain very aggressive targets for energy conservation and emissions reduction in large part through rapid expansion in the installation of renewable energy capacity.[7] China's investments in renewable energy in 2009 exceeded those made by the United States for the first time.[8]

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[4] Clean energy is defined as wind, small-hydro, solar, biomass, geothermal and marine.

[5] *The Notice of Requirements for the Administration of Wind Power Construction*, National Development and Reform Commission, 2005.

[6] Renewable Energy Policy Update for China, Eric Martinot and Li Junfeng, Renewable Energy World, July 21, 2010.

[7] Ucilia Wang, China's Solar Master Plan Sets Production, Efficiency and Price Goals," *Renewable Energy World.com* (February 24, 2012); Damien Ma, "Energy Policy to Fuel Economic Objectives," *China Daily* (March 21, 2011); 国务院关于印发"十二五"节能减排 综合性工作方案的通知 at http://www.gov.cn/zwgk/2011-09/07/content_1941731.htm.

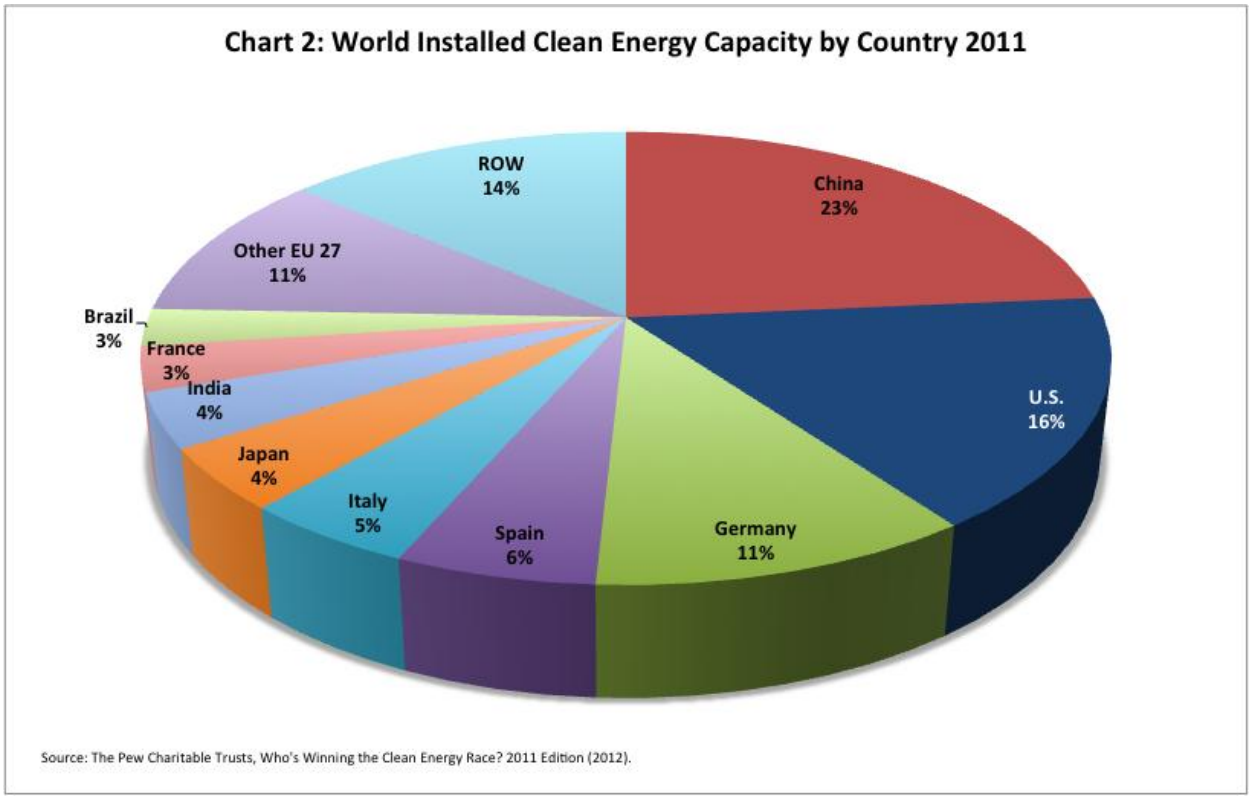
[8] http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Report/EXEC%20SUM_FINAL_LORES_WhoIsWinningTheCleanEnergyRace-REPORT-2012(1).pdf

Table 1. Installed Clean Energy Capacity - Top 5 Countries

(Capacity in GW, data as of December 2011)

	China		U.S.		Germany		Spain		Italy		World
	GW	*% World*	*GW*	*% World*	*GW*	*% World*	*GW*	*% World*	*GW*	*% World*	
Wind	64	26.8%	47	19.7%	29	12.1%	22	9.2%	6.7	2.8%	239
Small-Hydro	62	33.7%	25.3	13.8%	1.9	1.0%	4.4	2.4%	5.8	3.2%	184
Solar	3	4.1%	4.6	6.3%	25	34.2%	5.3	7.3%	12.4	17.0%	73
Biomass	4	7.0%	13	22.8%	5.7	10.0%	0.9	1.6%	1.9	3.3%	57
Geothermal	0	0.0%	3.3	30.0%	0	0.0%	0	0.0%	0.87	7.9%	11
Marine	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.6
Total	133	23.6%	93.2	16.5%	61.6	10.9%	32.6	5.8%	27.67	4.9%	564.6

Source: The Pew Charitable Trusts, *Who's Winning the Clean Energy Race? 2011 Edition* (2012).



The United States did lead the world in clean energy investment in 2011, followed by China, Germany and Italy. But this is a one-year snapshot. In 2011, U.S. investment amounted to $48.1 billion, largely in wind and solar power, coming in ahead of China's $45.5 billion for the first U.S. lead since 2008.[9]

[9] Bloomberg News Story on a Pew Charitable Trust finding. http://www.bloomberg.com/news/print/2012-04-12/u-s-clean-energy-policies-risk-losing-lead-over-china.html

Table 2: Clean Energy Investment by Country 2011 ($billion)

	2011 Investment	2010 Investment
U.S.	$48.0	$33.7
China	$45.5	$45.0
Germany	$30.6	$32.1
Italy	$28.0	$20.2
India	$10.2	$6.6
U.K.	$9.4	$7.0
Japan	$8.6	$7.0
Spain	$8.6	$6.9
Brazil	$8.0	$6.9

Source: The Pew Charitable Trusts, *Who's Winning the Clean Energy Race? 2011 Edition* (2012).

This is said by a number of observers to be short-lived:

> *The [U.S.] jump to the top of the G-20 ranking followed developers' efforts to finish projects before incentives expire. With China taking on long-term renewable energy targets and an American tax-break for wind lapsing in 2012, the U.S. again risks losing its edge, said Phyllis Cuttino, Pew's clean energy director.*
>
> *"China is sending that important policy signal which the United States is failing to do to for investors. Even though China has fallen to number two, it seems as though investment there is going to continue at a very significant level for the foreseeable future. They are going to continue to be a dynamic clean-energy hub for the world."*
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> *The U.S. doesn't have any comparable targets to China's goals of installing a total of 160 gigawatts of wind power and 50 gigawatts of solar power by 2020, she said. At the same time, a production tax credit benefiting wind producers expires at the end of the year. "In the absence of long-term policy, it's hard to see how the U.S. can grow significantly in the future. The boom-and-bust cycle of U.S. energy policy sends a very different signal to investors" from China.*

The U.S. led in investment in the year 2011 when the Recovery Act had its greatest impact. Many of the Act's provisions have since expired. For example, section 1603 has retired; the 48c Manufacturing Tax Credit has not been renewed; and the DOE Loan Guarantee Program is not expected to make significant future loans. In addition, it is worth noting that U.S. deployment incentives like section 1603 did not require the use of domestic products, so deployment-oriented incentives had an effect in both the U.S. and Chinese markets

The Defense Department is the nation's largest consumer of energy. In April, the department announced a fairly low goal of using 3 gigawatts of renewable energy by 2025--enough to power three-quarters of a million homes. One gigawatt is to be developed for use by each service branch: the Air Force by 2016, the Navy by 2020, and the Army by 2025,[10] although the Army is likely to develop and use double that amount. As if to underline the uncertainties caused by U.S. policies supporting the development of renewable energy, three weeks ago the Senate Armed Services Committee adopted amendments to the National Defense Authorization Act seeking to limit the Department of Defense(DoD)'s use of domestically produced alternative energy. Potentially cutting in the other direction, on May 21, 2012, DOD issued a Defense Federal Acquisition Regulation Supplement to promote utilization of domestic photovoltaic devices under energy savings, utility service and housing contracts.[11]

Despite China's investments in renewables, DOE reports that renewables account for only 0.2% of China's electric power generation, and of that wind has the largest share.[12] At least until a few years ago, about 95% of China's PV production was exported, and China accounted for about 55% of the world production.[13] Today, the GTM Research estimate is that for 2012 about 25% of all Chinese PV module production will be consumed domestically, and 75% will be exported.

Promoting U.S. competitiveness in clean tech vis-à-vis China

> *[T]he country fails to deploy into the marketplace the clean energy innovations it creates in the laboratory*[14]

When Bell Labs was at its peak it was an idea factory that gave rise to whole industries in the United States, and led ultimately to the creation of the semiconductor industry.[15] Globalization, improved transportation, freer trade and the internet have created a world in which there is locational competition for the production of most industrial goods and services, and clean energy related equipment and materials is no exception. Given the U.S. failure to commercialize its inventions to the extent that we once did, the Committee on Comparative Innovation Policies of the National Academies has engaged in an intensive seven year effort to

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[10] http://www.examiner.com/article/renewables-for-the-military-part-1-congress-vs-defense-dept

[11] 77 Fed. Reg. 30368 (May 22, 2012).

[12] U.S. Energy Information Administration, *Report on China*, March 2012. Large-scale hydroelectric power represents 6% and nuclear power represents 1%. Coal is the largest source of energy consumption at 71% in 2008.http://www.eia.gov/countries/cab.cfm?fips=CH

[13] Cleantech citing industry sources uses the 95% figure. NREL data does not appear to contradict these statements. http://cleantechnica.com/2012/02/12/dumping-solar-study-sheds-light-on-solar-pv-trade-flows-us-china-manufacturing/

[14] http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Report/EXEC%20SUM_FINAL_LORES_WhoIsWinningTheCleanEnergyRace-REPORT-2012(1).pdf

[15] *The Idea Factory: Bell Labs And The Great Age Of American Innovation*, Jon Gertner, Penguin Books Ltd, 2012.

study best practices of other countries. In our forthcoming report, we will make a series of recommendations of factors determining the location of not only invention but production. These recommendations could easily be the subject of a series of separate hearings While the report does not focus on the renewable energy sector, it does point to the cross-sectoral policy reforms that the United States should consider in order to enhance the production within the United States of what is invented here. The recommendations are extensive -- from the closer coordination of universities and the national laboratories with business, to manufacturing extension services and export promotion.

For renewable energy, more will be needed than simply greater efforts at export promotion or increasing manufacturing extension services. In most parts of the United States, clean energy for most applications is still more expensive than fossil fuel sources. Without subsidies and mandates, consumers will not choose clean energy, and private capital will not fund either research and development or deployment. A number of countries have promoted the installation of clean energy capacity with various types of subsidies (Germany, Spain, China, U.S., etc.) but budget constraints make a continuation of these policies difficult. This calls for even greater efforts to aggressively subsidize targeted R&D for clean energy to bring down the cost – making PV cells more efficient and wind turbines cheaper and more efficient, to take two examples. At the earliest stages of innovation, the U.S. remains very strong. We have some of the top research universities and national laboratories in the world. U.S. Government support for R&D has resulted in significant advances in these technologies, for example, the U.S. Department of Energy (DOE)-funded research over the past 35 years has yielded more than half of the world records in PV cell efficiency. Continued support for research and development can continue to lower the costs and improve performance for renewable energy technologies.

However, if this approach is taken alone, it will delay installation and use of clean energy capacity until it is economically feasible -- or until a carbon tax is levied on fossil fuels to reflect their social cost. Neither are situations likely to exist in the near term. Therefore support throughout the industrial chain from R&D through to commercialization and deployment need to be considered. As strong as the U.S. is in innovation, there are costs to the economy if we fall behind in transitioning these technologies to domestically manufactured products. Even though we are a world leader in patents and research publications, U.S. manufacturing market share for PV cells and modules has fallen dramatically, from 43% market share in 1997 to less than 4% in 2011. R&D support by itself is not sufficient to develop a healthy domestic industry.

A comprehensive and cohesive policy should have at least three major elements: 1) an R&D strategy to lower costs and improve performance so that clean energy technologies can be truly competitive without the need for long term subsidies 2) a manufacturing strategy that incentivizes domestic production and job creation to ensure a healthy industrial ecosystem, and finally, 3) a deployment strategy that helps transition these new technologies into the marketplace and gradually phases out support as the technologies are able to compete without support.

Whether to make major public investments to accomplish these ends is an important subject for public policy debate. On the one hand, there are clearly fiscal constraints that exist now that were not present when the manned space flight program was announced. In addition,

the current global industry is dominated by Chinese PV production, that even if dumped, is very low cost. On the other hand, U.S. innovation (and commercialization) from past national initiatives -- whether from Bell Labs, NASA, DOE, NIH, or DOE and the national labs -- have provided very substantial economic benefits, and support the commercial success of U.S. industry as well as ensuring growth in highly productive jobs.

Clearly, concentrated efforts by governments to support specific sectors have an effect on industrial development, whether here, China or in Europe. The staff of the Joint Committee on Taxation recently prepared a study on energy-related tax expenditures,[16] which I am sure that the Committee is familiar with. As noted above, the picture is one of an array of measures that are in most cases not of a reliably long duration. The electricity production credit provisions expire for wind at the end of this year. The Investment Tax Credit is considered to be at risk in tax reform given current fiscal pressures. The R&D tax credit is always extended on just a short term basis. The section 1603 Treasury Grant Program expired at the end of last year and is favored by the solar industry in preference to the advanced energy tax credit. The industry has also recommended that the Advanced Energy Manufacturing Tax Credit (MTC), which was over-subscribed, be renewed.[17]

The Department of Energy is making major efforts to support the development of solar energy, aiming to reduce the cost of solar energy systems by 75% before 2020. It seeks to enable widespread deployment of solar energy equipment in the U.S. without continuing subsidies. The SunShot Initiative is a business industry partnership with DOE funding support and with participation of universities and the national labs. The objectives are to return the U.S. to technological leadership, reduce energy costs generally, create employment, reduce greenhouse gas emissions and obtain a larger U.S. global market share. The Advanced Research Projects Agency—Energy (ARPA-E) within the Department of Energy (DOE) is also an important endeavor. The National Academy Report *Rising Above the Gathering Storm* stimulated and an authorization contained in passage of the America's Competes Act stimulated creation of ARPA-E. It was funded at a $400 million level through the American Recovery and Reinvestment Act (Recovery Act).[18] Its mission is to fund high risk energy research which holds some promise of dramatic results, and often to support public-private partnerships to do so. Future funding is not certain.

I cannot give you detailed prescriptions for tax and other measures to accomplish key renewable energy objectives. There are a number of government studies and industry papers laying out alternatives and recommendations that address these issues. But I have learned a few things in the course of studying and finding solutions to dealing with foreign industrial policies and the harm that they can cause to the U.S. industrial base. In particular, although the two sets

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[16] *Present Law and Analysis of Energy-Related Tax Expenditures*, Staff of the Joint Committee on Taxation, for the Subcommittee on Energy, Natural Resources and Infrastructure of the Senate Committee on Finance, March 23, 2012.

[17] See *Manufacturing Solar Photovoltaic Products in the United States*, the Semiconductor Equipment and Materials International (SEMI), 2012.

[18] ARPA-E's structure is codified in 42 U.S.C. 16538.

of challenges are not alike in all respects, there are several informative parallels to be drawn between the successful effort to preserve America's future in semiconductors and the challenges posed by China's promotion of its renewable electrical generating equipment industry.

In the early 1980s, the Japanese market was largely closed to imports of semiconductors. Access to that market was essential for our industry to remain competitive as Japanese companies dominated the downstream consumer electronics industries that drove semiconductor demand and technological progress. Japanese government-sponsored R&D through MITI's and NTT's laboratories moved the industry down the learning curve in terms of process and product. The vertically integrated Japanese producers were selling semiconductors below their average cost of production in all markets. Full-blown industrial policies generally lead to the creation of excess capacity, and this was the case in memory chips (DRAMs). The Silicon Valley start-ups – Intel, AMD, National and others, were in danger of extinction.

There were a series of antidumping cases filed and large duties were to be applied. But trade remedies were not going to be a sufficient American response. For one thing, this would have been a one-market solution and the relevant market was global. Elimination of dumping in the United States alone would threaten the erosion of downstream industries. The antidumping trade solution would also be one-dimensional. The U.S. companies needed unencumbered access to foreign markets, they needed to improve their manufacturing skills, they needed to be able to engage in pre-competitive joint R&D to do so, they needed to continue to attract capital, they needed to improve the protection of their intellectual property, they needed to make sure that universities were training engineers with relevant skills and they needed tax policies that supported their voracious need for R&D spending. In short, a complete strategy was needed to ensure the competitiveness of the U.S. industry, not just trade measures.

There was a recognized U.S. national security interest in maintaining a leading edge American industry. The U.S. industry united around a series of domestic and trade policy responses and achieved buy-in from the Executive Branch and strong support from the Congress. All of the necessary measures were put into place. A U.S.-Japan agreement on semiconductors ultimately opened the Japanese market for foreign chips and precluded dumping by Japanese companies in any market. The antitrust laws were amended to provide a limited safe harbor for pre-competitive R&D, the Defense Department matched industry contributions at a rate of $100 million per year for five years to improve the manufacturing capability of the U.S. industry with the creation of Sematech (the semiconductor manufacturing technology initiative). A new form of intellectual property protection was created for maskworks. The R&D tax credit was extended.

This endeavor required consistency of effort on the part of both industry and government over a very extended period of time. The necessary programs, begun by the Reagan Administration, and vigorously supported by its free-market advocates including George Shulz and Clayton Yeutter, continued during Republican and Democratic administrations alike with strong bi-partisan Congressional support. It took six years to put all the measures into place and another decade to make them fully effective. It was the right mix of policies, but it took crafting a comprehensive approach and consistent dedication to implementation to achieve the desired result.

Today, semiconductors figure among the top categories of U.S. exports each year. Amazing new greenfield facilities costing upwards of $4 billion each can still be created here (for example, Global Foundries in Upstate New York). Industry employment is in the hundreds of thousands. And U.S. companies account for a majority share of global production, double their share in the early 1980s. Moreover, the years of turbulence have been replaced by years of international cooperation on public policies. The EU, Korea, Taiwan and China have joined together with Japan and the United States to eliminate tariffs on semiconductors, work on energy saving both in semiconductor production and through the use of semiconductors in other industries[19], and collaborate on improving a very good record with respect to environmental impact through reduction of chemical use. The industries support this effort through their World Semiconductor Council (WSC), bringing their joint recommendations to a Government and Authorities Meeting on Semiconductors (GAMS) annually. [20] Global competition is vigorous and semiconductors, doubling in functionality every eighteen months in accordance with Moore's law, have enabled the information revolution.

The relevance of the success of the policy responses in semiconductors to the challenges faced in the renewable energy sector require answers to a series of questions:

- First: Can it be demonstrated that there is a vital national interest at stake in maintaining a domestic manufacturing base for the tools to make solar energy cells and for their production, and for the production of wind turbines?

- Second: Is there a case to be made that joint pre-competitive R&D and/or other support would have the potential for yielding benefits important to the American economy?

- Third: If the first two answers are affirmative, what policy prescriptions should be implemented?

The national interest

Although our current reliance on GPS, internet and wireless connectivity, I-Phones and hundreds of thousands of apps (applications) were at the time a quarter century away, the founders of the U.S. semiconductor industry had no doubt about whether their industry was vital to the nation's future. It took just over seven years to get Washington to fully share this vision.[21]

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[19] See John A. "Skip" Laitner, Chris Knight, Vanessa McKinney, and Karen Ehrhardt-Martinez, *Semiconductor Technology: The Potential to Revolutionize U.S. Energy Productivity*, Research Report E094, May 1, 2009, American Council for an Energy Efficient Economy, at http://aceee.org/research-report/e094

[20] See http://www.semiconductorcouncil.org/wsc/.

[21] The U.S. Semiconductor Industry Association (SIA) was founded in 1977 by the co-inventor of the integrated circuit, Robert Noyce, CEO of Intel, Charlie Sporck, CEO of National Semiconductor, Jerry Sanders, CEO of Advanced Micro Devices (AMD), who were soon joined by John Welty of Motorola. The association was formed to better understand the foreign industrial policy challenge from Japan, and to collect and publish industry data.

Factors leading to a consensus among policy makers included the fact that the country was locked in a Cold War with the Soviet Union and semiconductors had a central role to play in national defense. Moreover, the inherent unfairness of Japanese industrial policies, the closed Japanese home market together with U.S. industry's legal rights to at least stop the sales of Japanese semiconductors in the U.S. market at below cost of production, provided additional impetus to forming a U.S. consensus that a comprehensive response was necessary.

Can a national consensus be formed today on the following two points:

1) It is vitally important that clean energy account for a much greater share of U.S. energy supply -- for reasons ranging from reducing the environmental impact of energy production and use to greater energy independence and therefore increased national security.

2) A complete U.S. domestic industrial production and supply chain is required to deliver clean energy efficiently -- from R&D, to production of solar photovoltaic manufacturing equipment, materials such as polysilicon, modules, cells and turbines, through fabrication into panels and deployment into solar and wind farms -- because the entire industry is vital to the American economy. Is it acceptable for Chinese industrial policies, including protection and subsidies, to result in that country being dominant in the technologies and products that yield clean energy? Can the country afford not to explore to find which clean energy technologies lie just beyond the horizon, to forego forever whatever new discoveries lie in the future?

We do not appear to be near a consensus yet that will drive a comprehensive solution to our clean energy requirements and the challenge posed by China's policies and objectives. The newly apparent plentiful availability of natural gas is diminishing one of the drivers of finding near term solutions. But that does not mean that a path forward cannot be found. Natural gas is actually complementary to renewable energy, as the sun does not always shine and the wind is not always constant. And there should at least be a national debate about whether government choices abroad should be allowed to shape the U.S. economy. That China chooses to have these industries should not mean that the United States should relinquish them. That said, there are a series of interests that also must be taken into account. The U.S. will not want to slow the deployment of low-cost renewable energy equipment. Deployment has important ramifications for climate change, jobs, sustainable development and economic growth. Upstream industries, supplying silicon and other materials and leading the world in making the tools that produce photovoltaics are also vitally important. The entire value chain must be taken into account.

The author of this testimony and Tom Howell, both then of Dewey Ballantine, prepared a series of studies on the nature of the Japanese market during the early 1980s. This industry effort ultimately gave rise to bilateral inter-governmental consultations in 1984, a series of trade cases, a bilateral U.S.-Japan semiconductor agreement in 1986, and retaliation by the U.S. government against Japanese trade in 1987 for its failure to live up to that Agreement. Full compliance ensued.

Supportive Domestic Policies

The United States leads in the front end of innovation – invention -- in the renewables sector. It has the most patents and the most research spending, but it has been losing out over the last decade in commercialization, in domestic manufacturing. This is a general problem for the United States, studied in depth by the National Academies in several of its projects, including the work on Comparative Innovation Policies. The creation of a substantial number of additional manufacturing jobs is a high priority and the renewable energy sector is a natural place to look to see what can be accomplished, because there is more than one broad national policy goal to be served in focusing on this sector.

The renewable energy industries require a stable and viable rate of return in order to maintain and attract capital. This can be achieved through a variety of measures – ameliorating excessive market distortions caused by low cost imports that are the product of foreign industrial policies; continuing supportive tax policies, use of direct subsidies, and the use of renewable energy standards. These measures are advocated in various publications of industry groups.

The solar photovoltaics industry shares some of the same technologies as the semiconductor industry. It uses silicon, chemical deposition, photo-lithography among other similarities. Whether Sematech – that is government co-funding of joint industry pre-competitive R&D -- is a good model for this sector is well worth exploring.

Making renewable energies more cost competitive with fossil fuels should be approached not just from the side of creating demand and assuring an adequate rate of return, but also with the aim of making improvements in design and manufacturing technologies that will drive down costs. Those in the industry will have to decide whether they find a community of interest to engage in a common endeavor, and the government has to ascertain whether the national interest is served by spending more scare federal resources on an endeavor of this kind. It worked extraordinarily well for semiconductor manufacturing in the United States. And this joint endeavor led to other R&D efforts in this sector – to joint industry-government funding of university research through the Semiconductor Research Corporation (SRC), through Focus Center Research Program (FCRP) and Nanoelectronics Research Initiative (NRI). The industry also drove technological progress through creation of a technology roadmap – indentifying the technology challenges that would allow the creation of constantly increasing functionality.

Some questions that will have to be answered, that were answered in the affirmative for semiconductors and that resulted in the creation of a manufacturing technology research consortium are:

- Are either the competition from China a sufficient motivation for companies to engage in a common pre-competitive research endeavor or are there other external pressures that would cause them to do so?
- Is the ability to develop needed design technologies beyond the capability of any individual company?
- Is there a need to develop more effective manufacturing and process technology, leading to common testing and industry-wide standards?

- Can they achieve the necessary technology focus, determine the bounds of shared technology policy, and achieve effective means for technology transfer, while preserving vigorous competition? [22]

The renewables industries, and the PV-related industries alone -- with a relatively large number of participants with a variety of interests, is far more fragmented than was the semiconductor industry in the 1980s: The PV industry is more global by far than the U.S. semiconductor industry was. There are well-established, important additional interests in the PV value chain. For example,. project developers may have less interest in technological development than PV producers have.

What is clear, and was enunciated by Gordon Moore, one of the founders of Intel, is that Sematech played a key role in reversing the X-curve that was the chief measure of semiconductor industry performance. This referred to a chart showing that U.S. producers once had a much greater share of the semiconductor market until 1985/86 --having 57% to Japanese producers' 32%. But by 1988, Japanese share of worldwide production had climbed to about 52% and U.S. world share had dropped to around 27%. By 1991, there was another X cross over, and today, US share is about double that of the Japanese competition. Sematech delivered the necessary improvements in semiconductor-related technologies. When combined with other supportive public policies, Sematech proved to be highly effective.

Is there a need to support basic and applied R&D in renewables? We do not know where the technology will take us. We know that it is likely to improve efficiency of delivering renewables, but it can also result in dramatic breakthroughs and spin-offs, and this cannot be discounted. The applicability of the Sematech model deserves serious consideration.

Crafting an appropriate U.S.-China relationship on clean energy

The trade relationship with China is complex. It is far from being free of problems but they do not dominate the relationship in the same way that the trade friction with Japan did in the 1970's to the early 1990s. China has been open to foreign investment since 1978 (although interference by the Chinese government is pronounced in some sectors) whereas Japan was completely closed during the period of trade problems. Japan was (and is) an ally; China is sometimes a partner and more often perhaps a rival. U.S businesses were largely united in their grievances against Japan. The U.S. private sector, including associations and even individual companies have divided interests with respect to China – seeing China as one of the world's largest growing markets, a major source of supply, a major location of foreign investment, often a difficult competitor and sometimes a difficult host country.

During the earlier period I am using for comparison with China, Japan was only reluctantly and partially compliant with international trade rules. Chinese policies are still evolving. China had to change tens of thousands of laws and regulations to join the WTO, and to

[22] See remarks of Clark McFadden and Gordon Moore in Securing the Future – Regional and National Programs to Support the Semiconductor Industry, Government Industry Partnerships Project, National Research Council of the National Academies, 2003.

liberalize its economy very substantially in a very short time. And yet there is still an extensive list of barriers and market distortions with which foreign companies and their governments must contend. China accounts for the longest section of the U.S. Trade Representative's *National Trade Estimates* catalog of foreign trade and investment problems. Another difference in current trade relations with China as compared with earlier trade relations with Japan is that since the Uruguay Round was implemented in 1995, the United States has lost the freedom to retaliate whenever it made a unilateral judgment that its trade interests required it to do so. In addition, when the U.S. imposes trade measures, China has made it a practice to retaliate with its own trade actions which it seeks to justify under WTO rules, even if the measures it was responding to are fully justified under the WTO. Moreover, China has found the means to affect foreign trade in its pursuit of development of its industries in informal ways that are not necessarily as susceptible to being effectively remedied through WTO challenges.

In the case of imports into the United States of semiconductors from Japan, the dumping margins were prohibitive -- trade in some products would have ceased. Through the use of U.S. section 301, unilateral trade retaliation was available to enforce an agreement. In contrast, with the WTO green energy equipment subsidies case brought by the U.S., although a positive WTO ruling was achieved, did not yield much in the way of practical results. The final dumping determinations will not be made in the solar polysilicon case until the Fall, but if the duties and rates are along the lines of the preliminary findings (30-34% for dumping margins for 90% of the trade, a few percent for subsidy rates), the trade remedy may not be enough to change the serious situation in which the solar industry finds itself – since the decline in solar PV prices over the last eighteen months has been about double those percentages.

A complicating factor of antidumping relief is that it affects only shipments from one country. If the Chinese producers assemble panels in third countries, source cells from Taiwan, or set up factories in third countries, the trade remedy will likely not cover some or all of those shipments.

There is authority in the Commerce Department to work out a "suspension agreement" to waive the duties in return for potentially a quantitative restriction and a price floor covering China's shipments of the subject merchandise.[23] [24] This is perhaps possible to achieve if the

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[23] 19 USC 1673c provides in relevant part:

(l) Special rule for nonmarket economy countries

(1) In general

The administering authority may suspend an investigation under this part upon acceptance of an agreement with a nonmarket economy country to restrict the volume of imports into the United States of the merchandise under investigation only if the administering authority determines that—

(A)*such agreement satisfies the requirements of subsection (d) of this section, and*

(B)*will prevent the suppression or undercutting of price levels of domestic products by imports of the merchandise under investigation.*

d) Additional rules and conditions

The administering authority may not accept an agreement under subsection (b) or (c) of this section unless—

(1)*it is satisfied that suspension of the investigation is in the public interest, and*

(2)*effective monitoring of the agreement by the United States is practicable.*

[24] Examples of antidumping suspension agreements entered into with Chinese exporters include: Honey From the P.R.C., 60 Fed. Reg. 42,521 (ITA Aug. 16, 1995); Cut-to-length Plate from the PRC, 62 Fed. Reg. 61774 (1997).

Chinese government (which has effective control in this sector) believes that the final margins will be prohibitively high, and that it serves China's policy interests to enter into an arrangement of this kind (which it has done in some other cases prior to its entry into the WTO). While the domestic industry does not have a veto over these arrangements, it is consulted, and it is politically difficult for the U.S. government to compromise away what is taken in our legal system to be a right to trade relief -- unless the alternative is equally or more attractive to the petitioning domestic industry.

Had the U.S. antidumping case been coordinated with a trade case brought by the European Commission, something that has not to my knowledge ever happened, there would perhaps be more interest on the part of China in a settlement. Given the short time until the final determination at Commerce, the likelihood of a negotiated settlement by this Fall is probably close to nonexistent. It is not clear that sufficient inducements can be found to bring about an agreement to stabilize this trade. A settlement later is, however, possible -- especially with the consent of the U.S. petitioner industry.

What factors would militate toward a possible settlement? Are there common interests that can grow out of the following common objectives?

- Both China and the United States wish to deploy much more in the way of renewables, enhancing the role of renewables in the mix of their energy consumption.

- Both China and the United States seek to see the price of PV modules decline through increased efficiencies in both solar and wind to foster this objective.

- Both countries wish to maintain and nurture the industries that produce the supply chain for renewables.

- Both countries wish to foster the development of relevant technologies at home.

Despite having a number of interests in common, a trade skirmish is brewing. In the fall the U.S. will likely impose antidumping duties on Chinese exports. This is not a minor amount of trade, an estimated 2 gigawatts worth of solar modules were shipped into North America in 2012 from Chinese manufacturers, representing as much as 60 percent of the market, and about $3 billion in trade.[25] Three weeks ago today the Chinese Ministry of Commerce pronounced six renewable energy support measures granted by the states of Washington, Massachusetts, Ohio, New Jersey and California were grants as inconsistent with the WTO rules. Of course, U.S. shipments of renewable energy generating equipment such as wind turbines or solar modules to China is small compared with Chinese shipments of solar cells and modules to the United States – but the U.S. has strong export interests in the equipment to make solar cells, in exports of polysilicon and exports of high-value parts for wind turbines.

[25] http://www.isuppli.com/photovoltaics/pages/headlines.aspx.

What are China's principal interests? The most obvious immediate interest would be Chinese producers would wish to avoid making very large cash deposits in the U.S. Treasury for a long time to come on their exports . There is also the degree of uncertainty as to what the ultimate duty liability will be, which if the Chinese did not adjust their prices or cease shipping (the latter being extremely unlikely) would be very large. Trade does not thrive with uncertainty. Moreover, with a U.S. antidumping duty order in place on PV, the pressure on the European market will increase, perhaps triggering antidumping action there. (India may follow suit as well). There might be broader Chinese interests about cooperation on R&D in the area of renewables. It also may be that price stability with respect to exports would be in line with and reinforce any Chinese government plans to rationalize domestic overcapacity in wind and solar and increase its deployment of renewable energy sources both in terms of grid-connected and residential uses.

What are America's principal interests? The U.S. government is committed in principle to allowing industries to petition for trade relief and to receive it where warranted under the law. This is consistent with WTO rules where domestic industries are harmed by dumped or subsidized trade. That said, trade measures are only a very partial solution to strengthening the domestic U.S. renewables industries. To foster the deployment of renewable energy equipment and the industry producing the tool, equipment and materials for this equipment, there has to be a reasonable rate of return to continue to attract necessary capital. This objective can be served by a predictable and consistent level of support in terms of tax policy, DOE investments, feed in tariffs and clean energy standards. To reduce the need for financial supports and mandates through clean energy standards, the costs of producing renewable energy need to decline. Harnessing the research capabilities of universities and the private sector in a common effort to achieve this objective needs to be seriously considered. A potentially useful model has been provided by the interaction between the private sector and the U.S. government with respect to semiconductors.

Ultimately trade measures and domestic policies should be integrated and a strategic approach crafted to the U.S.-China clean energy set of problems. If there is an attempt at a grand bargain, access to the Chinese market for wind turbines produced outside China should be part of any overall settlement.

Would China avoid talks because it would not want the precedent established of its agreeing to settle antidumping cases with quantitative restrictions and minimum price provisions? Would it do so from fear that agreeing to a suspension agreement might lead to other calls for export restraints by China? It is hard to predict. I know of no instance where China has settled an antidumping order with the U.S. with export restraints since China joined the WTO. However, China, it should be assumed, can be pragmatic if it sees the balance of its interests served by a settlement, particularly if it were part of a very broad package. One consistent Chinese demand is that the U.S. liberalize its export controls. While the United States will not compromise its national security to reach any agreement with China, extensive technology-sharing actually takes place now, although informally, through foreign investment. Perhaps there is something in the technology arena – R&D with respect to clean coal or carbon sequestration – that would be of mutual interest and that could be added to an agreement providing for the complete elimination of dumping. This might occur through a broader program

or with more resources than currently exist for the U.S.-China Clean Energy Research Center (CERC).

Medium term, and not likely in the next few months, a trilateral (U.S.-China-EU) renewables accord might create added interest for China. My assumption is that none of the three – the U.S., China or the EU – is prepared to see the growth of its domestic renewables industries curtailed given its energy policy objectives? The World Semiconductor Council and the Governments and Authorities Meeting on Semiconductors may be models that can be employed to promote cooperation at the industry and government levels on mutually beneficial public policies. In that all three regions are supporting their renewables sector, it may be that a trade agreement makes some sense, incorporating and superseding antidumping relief.

The bottom line: It is not yet clear that sufficient inducements can be found to bring about an agreement providing for equitable trade that fosters long-term growth in these industries. This does not mean that there should not be further consideration given to the possibilities, and efforts made to find common ground Whatever the possibilities are of reaching an accommodation with China on PV, there is an overriding U.S. national interest in assuring that new leading edge technologies are developed and manufactured in this country, or we will lose the ability to do so. As the United States is the world's most innovative country, that would be a loss not just for the United States but for a world in which renewable energy sources must account for an increasing proportion of the supply of growing energy needs.