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# Clean Technology Manufacturing Competitiveness: The Role of Tax Incentives before the

**Senate Finance Committee**
**Subcommittee on Energy, Natural Resources, and Infrastructure**
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Senator Bingaman, Senator Bunning, and members of the Committee, I appreciate the opportunity to appear before you today to discuss the issue of U.S. competitiveness in the clean energy industry and the role of tax credits in enhancing that competitiveness.

I am the president of the Information Technology and Innovation Foundation. ITIF is a nonpartisan research and educational institute whose mission is to formulate and promote public policies to advance technological innovation and productivity. Recognizing the vital role of technology in ensuring American prosperity, ITIF focuses on innovation, productivity, and digital economy issues.

Global private investment in renewable energy and energy efficient technologies is estimated to reach $450 billion annually by 2012 and $600 billion by 2020, and much larger if recent market opportunity estimates are realized.[1] As such, the industry presents an important market opportunity for the United States, one that could lead to significant job creation and export markets. However, for the United States to regain economic leadership in the global clean energy industry, U.S. energy policy must include more significant and coordinated investments in clean technology R&D, manufacturing, deployment, and infrastructure. One key component of this includes support for clean energy manufacturing in general, and the Section 48c clean technology production tax credits, in particular. ITIF supports renewed funding for this program and, as described below, some modifications in the structure and function of the program.

## Why Demand Side Policies Alone Are Not Enough To Address the Challenge of Global Climate Change

Addressing the challenge of global climate change will require a transformation of the global production system, with significant reductions in greenhouse gas emissions. Because of population and per-capita income growth, achieving a 50 percent reduction in global greenhouse gas emissions by 2050 (the minimal reduction advocated for by most climate scientists) will require that each unit of economic activity produce 85 percent less green gas emissions than today. Achieving that level of greenhouse gas efficiency will require the development and deployment of new clean energy technologies.

The principal focus of climate change policy to date has been on boosting demand for clean energy technologies (and thereby reducing demand for “dirty” energy technologies), either by requiring reductions in carbon emissions (carbon caps or other regulations limiting energy use) or by increasing the price of carbon (carbon taxes or cap and trade). While such a demand side strategy is a key component of addressing climate change, it alone is insufficient to produce the kinds of changes needed.

This is true 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 as we are seeing, mustering the political will to impose even low prices on greenhouse gas emissions is difficult. Thus, political considerations mean that even if a carbon price is established it will likely be relatively low, as in the House’s version of 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 roughly a 15 cent increase in the price of a gallon of gasoline.[2]

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 not be enough to make mature and currently more expensive technologies such as solar energy or carbon capture and storage competitive. Only innovation and continued price declines in these technologies will allow them to be competitive with fossil fuels.

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 large level of uncertainty discourages high-risk, high-reward research in favor of short-term research and incremental product development, while also inhibiting the commercialization and adoption of technologies that require capital-intensive projects to demonstrate technological and financial performance at commercial scale.[3]

But there is an additional problem with relying principally on a price or regulation-induced demand side strategy for clean energy. One key factor in convincing the American public that climate change legislation is worth the (modest) short and moderate-term cost is to demonstrate the promise of good jobs in the clean energy industry. If climate change legislation raises costs, but at least results in the creation of significant numbers of good paying clean tech jobs, then it will likely generate more public support. Yet, without a policy focused on the supply side (e.g., developing a robust clean tech industry in the United States), there is a very real chance that any policies to spur demand for clean energy will simply result in that demand being filled by foreign supply. If that is the case and the United States continues to run trade deficits in clean energy, the United States will be a net loser of jobs in this growth industry.

This suggests that supporting clean technology research and production is a necessary component of any clean energy policy. Such subsidies need not distort what economists term “allocation efficiency.” Economists from a wide array of political orientations have long argued that “bads” (activities with negative externalities) carbon should be taxed, since the consumption of carbon creates costs to society that are not borne by the consumer (e.g., an organization or individual), and thus will be higher than what is optimal for society. Raising the price of carbon is one way to address this market failure, but as we have seen doing so has proven politically unpopular. The alternative is to subsidize non- or low-carbon alternatives in order to reduce their price. A principal advantage of the latter approach is that it addresses two issues at once: lowering the relative price of clean technology while at the same time increasing the likelihood that the demand for clean technology will be met in the United States, thereby creating jobs and reducing the trade deficit.

## The U.S. Risks Losing out on the Global Clean Energy Revolution

The U.S. should not assume that the clean energy industry is ours for the taking. Nations like China, Japan, South Korea, Spain and Germany are already outcompeting U.S. manufacturers, not through some inherent comparative advantage, but through direct public investment in clean energy research and development, manufacturing, and market creation. As ITIF and The Breakthrough Institute documented in "Rising Tigers, Sleeping Giant,", 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.[4] The United States already 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.[5] That's why China will export the first wind turbines destined for use in an American wind farm, in a project valued at $1.5 billion.[6] China now produces two times as many wind turbines as the United States, and both China and Japan are ahead of the United States in the production of solar PV cells. Overall, the report found the United States lagging far behind its economic competitors in the production of virtually all clean energy technologies. According to the New America Foundation, the U.S. balance of trade in renewable energy has moved from a trade deficit of nearly $300 million in 1997 to a deficit of $6.4 billion in 2008.[7] Should this gap continue to grow, 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 to 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. For the first time in 2008, China attracted more private investment[8] in clean energy than the United States and has since widened its lead. In 2009, China attracted $41 billion – and China's share of global clean tech investment is rising each year.[9] (China also attracts more private capital than any other country in the world, with $34.6 billion in private capital going into in China in 2009, nearly twice as much as went into the second-placed United States,$18.6 billion).[10]

One reason we are lagging behind is that other nations have put in place aggressive clean tech investment strategies. According to a recent study by Deutsche Bank, "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."[11] 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." In "Rising Tigers," we estimated that China, South Korea and Japan governments will invest a total of $509 billion in clean technology over the next five years (2009-2013) while the U.S. government 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.)[12]

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.[13] 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.[14]

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.[15]

Indeed, the largest investments are being made by China, which is planning new investments totaling at least $440 billion,[16] and up to $660[17] billion, over ten years. These investments are expected to focus primarily on low-carbon power, and are in addition to the $177 billion in stimulus funds China has already invested in clean technology, including rail and public transit.[18] In addition, local and provincial governments in China are establishing clean energy clusters—low-carbon development zones that offer 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 particular cluster is located in a city called Baoding, which is referred to as "Electricity Valley," and is composed of nearly 200 renewable energy companies focusing on wind power, solar PV, solar thermal, and biomass 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 a skilled labor force.

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.[19] Japan has unveiled a plan to generate 20 percent of its electricity from renewable sources by 2020. Both targets are backed up by targeted R&D investments, technology-specific deployment incentives, and government procurement programs. China plans to deploy 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 expects to generate from 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.[20]

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.[21]

### The Role of Supply-Side Clean Energy Policies

Current U.S. energy and climate policies focus on stimulating domestic demand primarily through indirect, demand-side incentives and regulations, with inadequate attention to supply. If these policies succeed in creating demand without providing robust support for U.S. clean energy manufacturing and innovation, the United States will rely on foreign manufactured clean energy products. This dependency is already occurring in many manufacturing sectors. Indeed, as the manufacturing goods trade deficit has increased over the last decade, U.S. manufacturing value added as a share of GDP has declined significantly.[22]

In order to avoid ceding first-mover advantage to Asia's clean tech tigers, U.S. support for the nation's already lagging domestic clean energy industries must be robust. Unfortunately, according to the Environmental Protection Agency, the climate and energy bill passed by the 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.[23] When compared to investments made by Asian competitors, ACESA directs relatively little public funding to directly 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.[24]

While the United States is facing challenges in the global race for clean energy competitiveness, we are still in the game and can thrive provided the right policies are put in place. Indeed, there are historic 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 development 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 countries like China, Germany, Japan and South Korea fully establish and cement their emerging competitive advantages.

## Why Foreign Clean Tech Policies Can Hurt the U.S. Economy

One rationale for not intervening on the supply side of the clean tech industry is that if these other nations want to subsidize their clean energy industry exports to us (or any industry exports, for that matter) that we should let them. After all, aren't their subsidies just lowering prices for American industry and consumers? What's wrong with this?

The fallacy of this logic is that it ignores the fact that most American consumers are also workers. In other words, foreign clean tech policies may help American consumers by lowering the price of clean energy, but they hurt American workers, at least in the short term and possibly in the moderate term. Consumers don't benefit much from lower clean energy prices if they are out of a job. These foreign policies clearly hurt American workers in the short term. For example, the wind turbines installed in Texas and manufactured by Chinese government subsidized producers clearly substituted for American produced wind turbines and either resulted in direct job losses or limited expansion of jobs in the U.S. wind energy industry.

Even if defenders of unilateral disarmament by the United States in the face of foreign clean technology subsidies acknowledge short-term harm to U.S. workers, they will argue that in the moderate term U.S. workers benefit. Their logic is that if workers are not employed in the clean tech industry because of foreign clean tech industrial policies, they will simply be employed in other U.S. industries. In the moderate and long-term this is true. But there are at least two problems with this analysis. First, they may not be employed in jobs with the same or higher levels of productivity and wages. In fact, average wages in the clean energy industry are higher than overall U.S. wages for industries associated with household consumption.[26] This suggests that the average worker not employed in the clean tech industry will make less, not more, money and U.S. GDP will be less, not more.

A second flaw in this logic is that it ignores the problem of the trade deficit. While there is disagreement among economists over whether the persistent and large U.S. trade deficit is a problem (ITIF believes that it is), there is much less disagreement of what the trade deficit represents: a debt owed by future generations of Americans. Currently Americans consume approximately 5 percent more than they produce (with the rest being made up of imports greater than exports). This is clearly unsustainable, if for no other reason that eventually other nations will tire of sending us their products and getting nothing in return for them. When that happens it means that Americans will have to consume approximately 5 percent *less* than they produce, for at least several decades, and this will likely happen when the baby boomers are retired. ITIF believes that for this reason alone, coming to grips with the trade deficit now is good public policy. Supporting clean energy production, as Section 48c does, is one way to do this.

**The Role of Clean Energy Tax Credits**

Public investment helps 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.[27]

It is in this context that the Section 48c program plays an important role. The American Reinvestment and Recovery Act of 2009 (ARRA) authorized the Department of Treasury to award $2.3 billion in tax credits for qualified investments in advanced energy projects, to support new, expanded, or re-equipped domestic manufacturing facilities. The Section 48C program has so far provided a 30 percent tax credit for investments in 183 manufacturing facilities for clean energy products in 43 states. This program helps support U.S. manufacturing capacity to supply clean energy projects with U.S. made parts and equipment. These manufacturing facilities should also support significant growth in exports of U.S. manufactured clean energy products. After implementation, the program was oversubscribed by a ratio of more than 3 to 1. Over 500 applications were received with tax credit requests totaling over $8 billion. This clearly suggests that there is a significant capability to produce clean energy technology in the United States. It also suggests that DOE could tighten the criteria by which they make awards to increase the overall effectiveness of the program.

ITIF believes that Congress should extend this program. However, if Congress does this, we would recommend several changes in the program.

- Congress should consider expanding the program to provide some grants, as well as tax incentives. Under the current program newer firms with limited tax liability find the program of less use (they can presumably carry forward their tax credits for future years when they may have federal tax liability, but this is of less use than being able to receive the support sooner).

- In order to extend the scope of the program, Congress may want to consider lowering the credit from 30 percent to 25 percent (or even 20 percent) and encouraging state governments to provide matching funds. States and local governments should be in a position to help support these investments since these projects will clearly have strong state and local economic development benefits.

- The program should fund only projects that have not yet been initiated. While it may have made some sense to fund projects that had already been initiated because the U.S. economy was in the midst of a severe economic downturn when the program was established, going forward only new projects should be supported.

- Eliminate (or at least significantly downgrade) the criteria for awards of the "Shortest project time from certification to completion." One factor in determining winning projects was speed of completion. While this criteria made sense during the downturn when it was critical to stimulate economic activity quickly, it makes less sense now with recovery under way. We would recommend eliminating this criteria as speed of completion as a selection criteria.

- Eliminate (or at least significantly downgrade) the criteria for "greatest domestic job creation (direct and indirect)." Again, this factor made sense during the downturn. But giving this criteria significant weight can disadvantage projects that are more capital intensive, more innovative, and more export focused.

- Eliminate (or at least significantly downgrade) the criteria for "greatest net impact in avoiding or reducing air pollutants or emissions of greenhouse gases; lowest levelized cost of energy." This goal is obviously a critical one. But the real issue in how it is applied is the time horizon for the generation of these benefits. Strict application of this criteria could result in some projects with higher short-term energy benefits (such as factory producing insulation) winning out over other projects with slightly lower short-term benefits (such as solar panel production).. But a potential advantage of funding the solar panel project is that economies of scale and learning are achieved, plus more revenue is gained for reinvestment in solar energy R&D. Achieving the 85 percent greenhouse gas efficiency improvement requires more than energy efficiency measures. It will require new technology measures, such as new lighting technology, new renewable energy technology, new energy storage technology, more efficient carbon capture, etc. These are the kinds of projects that should be prioritized in the 48c program.

- Give more weight to “greatest potential for technological innovation and commercial deployment.” As noted above, this is an important factor that deserves to be weighted more heavily in DOE project selection.

- Add a criteria that rewards projects that are likely to lead to greater exports (or reduced imports). It is the product areas that are most exposed to robust international competition that are in most need of federal government support, if for no other reason than to offset the competitive advantage that foreign competitors get from help from their domestic governments.

- Related to this, the program should prioritize projects that produce components or products domestically, as opposed to just assembling components produced overseas. Assembly plants are more likely to have to be located in the United States regardless of whether there is a tax credit given to them or not. Moreover, the job creation benefits from component production are usually much larger than from assembly plants, as the former usually either get exported or assembled domestically.

*A More Integrated Clean Energy Technology Strategy is Needed*

While the 48c program is an important tool towards both increasing clean energy jobs in the United States and addressing global climate change, it is not enough. Ultimately, developing a globally competitive clean energy industry will require not only support for clean energy manufacturers, including but not limited to incentive programs like 48c, but also a comprehensive efforts to spur innovation and collaboration throughout the clean energy sector, from research to technology commercialization and production.

Therefore, tax credits for advanced clean energy manufacturing are one piece of what must be a larger public strategy to build a robust clean energy economy. The federal government must also ensure adequate investment in clean energy research and development to advance next-generation energy technologies to improve their performance and make them cheaper,[28] and accelerate the opportunities to manufacture and commercialize new technologies by providing stable and long-term demand. In this regard, ITIF believes that any climate change legislation considered by Congress should invest much more in research, innovation and advanced production, even if it has to reduce the tax on greenhouse gases emissions (for example, by a less aggressive carbon cap).

New institutional models are also needed to coordinate investments in R&D, manufacturing, and technology commercialization and spur public-private collaboration to accelerate the pace of innovation throughout the technology value chain. A large body of scholarship has identified regions as the most effective delivery mechanisms for such coordination, and we have proposed that the federal government offer grants to create regional clean energy innovation clusters to link federal and non-federal investment in clean energy and maximize the economic impact of our federal dollars.[29]

Finally, we need to supplement domestic clean energy policies with a trade policy that challenges clean technology protectionist policies in other nations. As the National Foreign Trade Council recently documented in a report on Chinese policies to support their renewable energy industry, many Chinese practices are clearly protectionist.[30] ITIF believes that it is important to differentiate between polices that are generally positive sum (such as subsidies for clean energy research and production) and those that are designed to limit imports and spur exports in clearly protectionist ways. In the case of China, the government is aggressively using both kinds of policies, but among the latter include VAT rebates; procurement preferences for Chinese-owned and controlled companies; and local content preferences (not to mention their manipulated currency as an overall export subsidy). For example, China enacted a rule that provided that no wind farm could be constructed in China that did not meet a 70 percent local content requirement. They also released the Provisional Measures for the Accreditation of National Indigenous Innovation Products which provides for a process under which products made with "indigenous" (e.g., Chinese) intellectual property could qualify for "priority" in government procurement and "national key projects that will spend Treasury funds." In other words, China's "Indigenous Innovation" program is simply a protectionist regime applied to technology-related industries, including clean tech, and one that has the potential to severely hurt U.S. technology companies. As such, it is time for the U.S. government to stop sitting on the sidelines and begin to seriously challenge other governments' clean-tech protectionism.

**Conclusion**

U.S. manufacturing output (as a share of GDP) and jobs have declined in the last decade. One way to help revive both is for the United States to gain a larger share of the expanding global clean energy industry. Doing so will not only produce jobs in the United States, it will help address the challenge of global warming. However, absent supply-side policies to support clean energy innovation and production this revival is unlikely to occur. Ultimately, creating a robust clean energy economy in the United States will require a more integrated investment strategy to support clean energy research, commercialization and production. Toward that end, reauthorizing and refining Section 48c support for clean energy production is critical.

**Notes**

[1] World Economic Forum, "Green Investing: Toward a Clean Energy Infrastructure," World Economic Forum, January 2009, http://www.weforum.org/pdf/climate/Green.pdf. For example, a recent opportunity estimate for China alone estimated a maximum market opportunity of $500 billion to $1 trillion by 2013. See:"The China Greentech Report 2009." *China Green Tech Initiative*, September 10, 2009,16, http://www.china-greentech.com/reportweforum.org/pdf/climate/Green.pdf.

[2] 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. See: Larry Parker and Brent Yacobucci. "Climate Change: Costs and Benefits of the Cap-and-Trade Provisions of H.R. 2454." *Congressional Research Service,* September 14, 2009.

[3] Karsten Neuhoff, "Large-Scale Deployment of Renewables for Electricity Generation." *Oxford Review of Economic Policy*, Vol 21, (1) (2005).

[4] Robert Atkinson et al., "Rising Tigers, Sleeping Giant," Breakthrough Institute and Information Technology and Innovation Foundation, November 2009, http://www.itif.org/files/2009-rising-tigers.pdf.

[5] 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. See, Choma, Russ. "Overseas Firms Collecting Most Green Energy Money," *Investigative Reporting Workshop*, http://investigativereportingworkshop.org/investigations/wind-energy-funds-going-overseas/; Solar: "Marketbuzz 2009 Annual World Photo Voltaic Market Review." Solarbuzz LLC (March 2009), 130, http://www.solarbuzz.com/Marketbuzz2009-intro.htm;
Vehicles: "China Vies to be World Leader in Electric Cars," *New York Times*, April 1, 2009, http://www.nytimes.com/2009/04/02/business/global/02electric.html?_r=2&hp=&pagewanted=print.

[6] John Collins Rudolf, "China-U.S. Group Plans to Build Texas Wind Farm," *The New York Times*, October 29, 2009, http://www.nytimes.com/2009/10/30/business/energy-environment/30wind.html?scp=2&sq=China%20texas%20wind&st=Search

[7] Samuel Sherraden, "Green Trade Balance," New America Foundation, June 2009, http://www.newamerica.net/publications/policy/green_trade_balance.

[8] Deutsche Bank Group. Global Climate Change Tracker: An Investor's Assessment. October 2009.

[9] Ibid. See also: United Nations Environmental Program, *Global Trends in Sustainable Energy Investment 2009*, 2009.

[10] 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

[11] Deutsche Bank Group. Global Climate Change Tracker: An Investor's Assessment.

[12] Robert Atkinson et al., "Rising Tigers, Sleeping Giant."

[13] 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. See Robins, Nick; Clover, Robert and Charanjit Singh, "A Global Green Recovery? Yes, but in 2010." HSBC Global Research, August 6, 2009, p.2.
See also: "Gov't Unveils Plan to be Among the Top Green Nations." Government of South Korea. July 7, 2009, http://www.korea.net/news/issues/issueDetailView.asp?board_no=20963.

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

[15] "China Vies to be World Leader in Electric Cars." New York Times (April 1, 2009). Available at: http://www.nytimes.com/2009/04/02/business/global/02electric.html?_r=2&hp=&pagewanted=print .

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

[17] "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.

[18] Nick Robins, Robert Clover, and Charanjit Singh, "A Climate for Recovery: The Colour of Stimulus Goes Green".

[19] Ibid.

[20] See "Asia's First-Mover Advantage" in Atkinson et al., "Rising Tigers, Sleeping Giant."

[21] Ibid.

[22] Leaving out NAICS 334 (Computer and Electronics Manufacturing), U.S. manufacturing value added has fallen from around 13 percent of GDP in the late 1990s to less than 10 percent today. It appears that the Bureau of Economic Analysis considerably overstates the growth of value added in NAICS 334, thereby masking U.S. manufacturing decline. See: Robert Atkinson, "Comment on Gregory Tassey's Rationales and Mechanisms for Revitalizing U.S. Manufacturing," *Journal of Technology Transfer*, March 19, 2010, (http://www.itif.org/files/2010-Atkinson-JTT.pdf).

[23] U.S. Environmental Protection Agency, "Analysis of H.R. 2454 in the 111th Congress, the American Clean Energy and Security Act of 2009," June, 2009, http://www.epa.gov/climatechange/economics/economicanalyses.html.

[24] 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: "EPA Analysis of the American Clean Energy and Security Act of 2009." U.S. Environmental Protection Agency, June 23, 2009), http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis.pdf; And: "H.R. 2454, American Clean Energy and Security Act of 2009," U.S. Congressional Budget Office (June 5, 2009) http://www.cbo.gov/doc.cfm?index=10262.

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 "Over-Allocation of Pollution Permits Would Result in No Emissions Reduction Requirement during Early Years of Climate Program," Breakthrough Institute, September 23, 2009, http://thebreakthrough.org/blog/2009/09/climate_bill_analysis_part_20.shtml

[25] John Alic et al., "U.S. Technology and Innovation Policies." *Pew Center on Global Climate Change*, 2003. http://www.cleanenergystates.org/library/Reports/Pew_US-Technology_and_Innovation_Policies.pdf. See also: Zach Arnold et al. "Case Studies in American Innovation" Breakthrough Institute, http://thebreakthrough.org/blog/2009/04/breakthrough_report_case_studi.shtml.

[26] Robert Pollin et al. found that the average pay of the green investment program is about 14 percent higher than that for the industries associated with household consumption. See: Robert Pollin, Heid Garrettd-Peltier, James Heintz, and Helen Scharber, "Green Recovery: Programs to Create Good Jobs and Start Building a Low-Carbon Economy," Center for the American Progress, September 2008, http://www.americanprogress.org/issues/2008/09/pdf/green_recovery.pdf.

[27] Karsten Neuhoff, "Large-Scale Deployment of Renewables for Electricity Generation," *Oxford Review of Economic Policy*. Vol 21. (No 1.) (2005).

[28] There is strong expert consensus for the need for greater investment in clean energy R&D, on the order of an additional $15 billion per year. This scale of investment has been endorsed by 34 Nobel-prize winning scientists, the nation's top research universities, and leading think tanks and private sector technology companies like Google, See:

Jesse Jenkins, "The Innovation Consensus: $15 Billion for Clean Energy R&D," *TheEnergyCollective.com,* October 29, 2009, http://theenergycollective.com/TheEnergyCollective/50750.

[29] Reference forthcoming in an ITIF-Breakthrough Institute report.

[30] Thomas Howell et al., "China's Promotion of the Renewable Electric Power Equipment Industry," Dewey and LeBoeuf LLP for the National Foreign Trade Council, March 15, 2010, http://www.nftc.org/newsflash/newsflash.asp?Mode=View&id=236&articleid=3015&category=All.