Testimony of Professor Andrea Larson

Darden School of Business, University of Virginia*

Before the U.S. House Committee on Energy and Commerce

Subcommittee on Commerce, Trade and Consumer Protection

Topic: "Growing U.S. Trade in Green Technology"

Wednesday, October 7, 2009

larsona@darden.virginia.edu

The Subcommittee is interested in exploring how the U.S. trade in "green technology" might be expanded. My comments are captured in three interrelated recommendations:

- **INVEST IN CLEAN ENERGY & MATERIALS**
- **USE GREEN TECH TO DRIVE ECONOMIC DEVELOPMENT DOMESTICALLY**
- **SUPPORT U.S. GREEN TECH COMPETITIVENESS**

Green technology and clean commerce are the future. Green technology has become, and will increasingly be, a major economic growth area for the U.S. and world trade. There is no reason the U.S. cannot be a world leader through export of clean technology and clean commerce innovation, and U.S. leadership should be a strategic goal.

Why? Because:

1. **Investing in clean energy and clean materials is essential for intelligent economic development, human health protection, and ecosystem preservation**
2. **U.S. leadership in clean energy and materials (green technology) creates jobs, stimulates innovation, drives exports, and differentiates U.S. technology, education, and skills in global markets**
3. **The U.S. could have an advantage in world trade, but on the current path the U.S. will continue to fall behind**

<u>Green tech and clean commerce is the future</u>. Population and economic development pressures are colliding with the ability of nature to deliver clean air, water, and soil. Yet the design of the industrial system that brought us to this point in history was based on assumptions of limitless resources and limitless capacity for natural system regeneration, even in the face of our waste streams. Responding to climate change and green tech

opportunities are just the beginning of a major shift in this century for business. New design for business is imperative because the forces of change are accelerating.

It is not just the current economic downturn that confounds us. We face unacceptable income and opportunity disparities at home and poverty worldwide as global population grows from 6.5 to 9 billion in the next few decades. Worldwide over 2 billion people are moving rapidly into the middle class, and they will want all the opportunities and material wealth that the richest populations in western societies now view as normal. Today we concurrently face an economic downturn, a climate crisis, an energy security crisis, energy price volatility, new environmental health challenges, and ecological systems in dramatic decline.

If that were not enough, the U.S. also faces a competitiveness crisis as it loses ground to other countries that are already strategically committed to mobilizing state resources behind domestic businesses that will produce solutions to these problems. Other countries have mounted national efforts to reach clean commerce goals (e.g. renewable energy, domestic "green" companies, dramatic efficiencies, accelerating advances in PV solar design innovation, advancing clean public transportation, protecting consumers from toxic materials, and providing subsidies and incentives to advance their industries in global markets).

The larger picture shows capitalism as currently designed is at a crossroads.[1] It must deliver on its promise of broad prosperity, yet its very design appears to undermine the ecological systems and healthy communities on which it depends. It needs an overhaul: clean energy and materials provide an answer. The U.S. should be leading this change, not following.

Personal Introduction

I serve on the faculty of the Darden School and have conducted research and taught there for twenty years in the areas of innovation and entrepreneurship, strategy, and sustainability (cleantech, clean commerce). Prior to that I worked on consumer product safety, clean energy, and environmental concerns in the public (state and federal agencies) and non-profit sectors. My work has enabled me to see first-hand the emergence and rapid growth of a "clean commerce" approach to business that is re-designing the delivery of products and services. This approach – if fully understood and supported – can provide jobs, urban revitalization, health benefits, clean energy and transportation, sustainably produced and healthy foods, and – if appropriate policies are in place – offer the U.S. the opportunity for global leadership in green tech and clean commerce, capitalism's next chapter.

What is Green Technology?

Green technology is one term of several used today to encompass a range of activity and innovation to simultaneously address economic development needs, health protection, and preservation of ecosystem services (e.g. the natural systems that provide us with clean air,

*this testimony is provided as an individual statement

[1] Stuart Hart, *Capitalism at the Crossroads* (Wharton School Publishing, 2005).

water, soil, and food). Other terms include sustainability, clean commerce, cleantech, sustainable business, and sustainability innovation. The activities these terms reference challenge existing ways of designing and delivering not just energy, but the entire set of interdependent systems and supply chains that provide food, shelter, consumer products, and transportation modes.

We will use the abbreviation GT/CC throughout this testimony to refer to green tech and clean commerce, two terms that capture the ideas under discussion.

GT/CC refers to technology innovation, but also non-technical innovation, the latter represented by innovative supply chain management or innovative financing mechanisms to install urban PV solar installations that pay residents to sell excess electricity back to the grid. The non-technical innovative frontier must also be a focus for green tech and clean commerce innovation and U.S. competitiveness.

Furthermore, GT/CC is not just about energy. The fundamental basis of commerce and trade is energy AND materials. Both must be managed and designed to meet human needs and optimize ecological system functions. Thus green chemistry and green engineering practices are equally as important to green tech and clean commerce (GT/CC) as renewable energy technologies. PV solar systems that expose their production workers to toxins, are thrown away in landfills after use, then pollute water supplies, are not the solutions we need. "Fresh" vegetables and fruit grown with agricultural chemicals, processed, and transported thousands of miles and lacking fundamental nutrients that urban garden-grown food provides are not the solutions we need. More efficient lighting replacements that create mercury waste may save energy but are still poor designs. In other words, poorly thought out, so-called green technology improvements focused on today's hot topics (climate and energy are the focus today) are common. But a deeper design perspective is needed. First, a systems view is required. One that understands every "green" energy solution, in fact every energy AND product selection by a company or a consumer, reflects materials choices and embedded energy decisions that must be made visible, examined and evaluated for their life cycle implications. Fortunately this is now happening, led by innovative entrepreneurs. But it must be expanded and accelerated.

Nor is GT/CC just about efficiency. It is about that, but more importantly it is about innovation. Efficiency just allows us to do the same old things at lower cost and using less energy and fewer materials. A laudable improvement, but not the solution. Innovation creates fundamentally new solutions, preferably systems-oriented solutions that prevent and eliminate the problems we face now with climate alteration and unsafe products.

The concept that ties together innovation and both clean energy and materials is the notion of cradle to cradle design.[2] Our current commercial practices extract raw materials, make products, generate waste streams that impact air and water, expose production workers, sell to consumers who use the products and throw them away, and leave the materials to decompose and contaminate our air and water from the landfill, incinerator or Third World country dumping destination. Think about how the costs and benefits are allocated in this linear system. This is called a cradle to grave product life cycle. The alternative is

[2] Willian McDonough, Michael Braungart, *Cradle to Cradle* (New York: North Point Press, 2002).

cradle to cradle design derived from systems thinking, that reduces or eliminates energy and material inputs, including toxicity BY DESIGN FROM THE OUTSET to avoid employee, user/consumer, and ecosystem contamination. Under a cradle to cradle design, selected materials can be safely returned to the earth or maintained within closed recycling systems that use waste from one production and use process, as the feedstock for another.

Green technology and clean commerce issues (GT/CC) constitute a central challenge for governments. Providing ever growing volumes of products and services under current design parameters to support economic development also gives us pollution and costs that are inequitably externalized onto the population in one form or another (higher taxes for regulation, disease, and more expensive health insurance for chronic illnesses). Examples are air pollution (excessive concentrations of toxins in the air contributing to the asthma epidemic), unsafe foods (linked to diabetes, obesity, and food contamination), excessive low level air pollution and atmospheric carbon dioxide concentrations (respiratory illness, and climate change and volatility), and water quality threats and shortages due to industrial contamination.

As world population rises to 9 billion in the next few decades and capitalism as currently designed strains to deliver prosperity to more people, a clean commerce solution is emerging. This is an alternative approach to business that we call GT/CC (green technology and clean commerce). This movement is obvious in the current emphasis on clean energy alternatives in response to climate change.

But less visible in GT/CC is the movement to design out molecular toxins in everyday products. This is the *clean materials design revolution*, the counterpart to the clean energy movement. Together the clean energy and clean materials efforts offer a way to simultaneously address environmental health problems, clean air and water supply issues, low carbon solutions for energy and transportation, job creation, and urban and rural revitalization while moving away from fossil fuels (with their energy security, health, and climate/ecological problems) and building American competitiveness in the fast-growing clean commerce markets worldwide.

GT/CC in business is already happening but at a scale and scope that needs to be magnified over the next few decades. GT/CC encompasses material and energy system design characterized by what we have discussed thus far. This mean it includes products (consumer and B2B) designed with green chemistry and engineering principles, renewable energy sources (solar, wind, geothermal, hydro, or wave), and every other effort underway to move from fossil fuel feedstock and toward more systemically benign ways to meet human needs (biofuels and bio-materials; smart grid innovation; energy efficiency; advanced batteries, fuel cells, and hydrogen transport/energy systems all designed from a life cycle perspective; clean public transportation; sustainable agriculture; and green building and construction).

Next we shift to the core question of these hearings, the challenge of growing the U.S. clean commerce presence in world markets. A major challenge for the U.S. is the extent to which it currently lags other countries. The American Recovery and Investment Act of 2009

(ARRA) begins to address these issues but there is still much that can be done to lift the country to a trade and commerce leadership position.

U.S. Competitiveness

Transformation in the next decade to an alternative mindset about energy and materials is key to U.S. competitiveness and mandatory if global society is to handle the challenges of population growth, energy demands, and material throughput volumes required to provide prosperity for billions more people. We can choose to let others lead or we can mobilize and combine all the elements we have in this country to lead.

This discussion acknowledges that the U.S. has declared 25% renewable energy goals by 2025 with the February 2009 ARRA legislation. The clean technology stimulus accounts for about $66 billion, just ahead of China's stimulus investment. The important fact, nonetheless, is that we come to the table late. By way of example, according to the U.S. International Trade Commission, "Denmark, Germany, India, Japan, and Spain accounted for a combined 91 percent of global exports of wind-powered generating sets in 2008."[3]

Globally, investments in GT/CC have been growing rapidly. For instance, new investments in sustainable energy increased between 25% and 73% annually from 2002 to 2007, until growth fell to only 5% in 2008 following the 2007-08 recession.[4] Nonetheless, even in 2008, total investments in sustainable energy projects and companies reached $155 billion, with wind power representing the largest share at $51.8 billion. Meanwhile, the world's 12 major economic stimulus packages proposed to invest another $180 billion collectively in coming years.[5] Also in 2008, sustainability-focused companies as identified by the Dow Jones Sustainability Index or Goldman Sachs SUSTAIN list outperformed their industries by 15% over a six-month period.[6] Longer horizon analyses indicate companies screened for sustainability factors match or exceed the performance of conventional firms. These are companies that focus not only on renewable energy sources but also energy conservation, environmentally safer products, and improved corporate governance.

Despite being a leader in some areas, however, the U.S. was not an overall leader in GT/CC. From 2000 to 2008, venture capital investments in U.S.-based renewable energy companies increased from 0.6% of all VC investments to 11.84%, and in 2008, venture capital and private equity made new investments in energy efficiency and renewable energy worth $7.72 billion in North America and $3.05 billion in Europe.[7] Moreover, the U.S. had the most GT/CC business incubators in 2008, with 56.[8] The UK was next in incubators with 21, and 16 were in Germany. Yet Europe as whole was home to 46% of the global total of incubators, versus 40% for the U.S.[9] Furthermore, North American investments in sustainable energy shrank 8% in 2008 to $30.1 billion, while in Europe they increased 2%

[3] United States International Trade Commission, "Wind Turbines: Industry and Trade Summary," July 2009, iii.
[4] UNEP, *Global Trends in Sustainable Energy Investment 2009*, 10.
[5] UNEP, 10.
[6] A.T. Kearney, Inc., "Green Winners," 2009, 2.
[7] UNEP, 30.
[8] Clean Edge, Inc., *Clean Energy Trends 2009*, 6; UNEP, 26.
[9] UNEP, 26.

to $49.7 billion. Many other major emerging economies also saw investments in their renewable energy sectors increase: Brazil's increased 76% to $10.8 billion (mainly due to ethanol), China's increased 18% to $15.6 billion, and India's increased 12% to $3.7 billion.[10] Even in Spain investments reached $17.4 billion in 2008,[11] or $430 per capita compared to North America's $57 per capita. For investments specifically in publically traded renewable energy and efficiency companies, Chinese companies led in 2008 with $2.8 billion, followed by Portugal ($2.6 billion), the U.S. ($2.1 billion), and Germany ($1.5 billion). In fact, in 2008, China became the world's largest manufacturer of photovoltaic panels, with 95% of them destined for export.[12] This output means China may soon surpass both German and American manufacturers.[13]

Indeed, China has recently made massive moves toward a CT/CC economy. For instance, China now has 60% of the total global capacity for solar thermal water heaters. Even such a relatively minor innovation saved 3 million tons of oil equivalent in 2006 according to the International Energy Agency.[14] China is also nurturing and protecting its domestic wind power producers, reserving contracts for them and restricting foreign firms. The size of China's market for GT/CC creates significant opportunities for development of domestic innovators and mass producers. Nonetheless, China has a way to go: other countries have put themselves into leadership positions over the past two decades through a series of policies. Those world leaders have been Japan, Denmark, Spain, and Germany.

In 1996, Japan set a target by 2010 of using 3% (roughly 19 gigaliters oil equivalent) of primary energy supply from renewable sources excluding hydropower and geothermal energy. In 2008, the target was amended to represent an upper bound while 15.1 Gl was established as a lower bound.[15] That goal plus grants for residential solar PV installations allowed Japan to lead the world in installed solar capacity from 1999 to 2005, which also allowed Japanese companies such as Sharp to gain an early manufacturing lead. Sharp and other Japanese companies remain competitive in the U.S. market to this day, even though Germany overtook Japan in installed capacity in 2006.[16] In 2007, Japan established Renewable Portfolio Standards that required utilities to use renewable sources of electricity generation, to reach 16 TWh by 2014.[17] The RPS also set prices for solar PV rates, and in December 2008, Japan allocated another $9 billion for solar subsidies, which is less than California's current solar subsidy program but reaches more eligible people.[18] Japan continues to invest in solar research, including space-based solar energy.

---

[10] UNEP, 12.
[11] UNEP, 19.
[12] UNEP, 34, 49.
[13] Keith Bradesher, "China Racing Ahead of U.S. in the Drive to Go Solar," *New York Times*, Aug. 24, 2009, http://www.nytimes.com/2009/08/25/business/energy-environment/25solar.html?_r=1; UPI, "West vs. China in solar war," Sep. 9, 2009, http://www.upi.com/Energy_Resources/2009/09/09/West-vs-China-in-solar-war/UPI-25781252515090/.
[14] IEA, *World Energy Outlook 2008*, 176.
[15] IEA, http://www.iea.org/textbase/pm/?mode=re&id=4248&action=detail.
[16] UNEP, 19.
[17] IEA, http://www.iea.org/textbase/pm/?mode=re&id=3591&action=detail.
[18] UNEP, 20.

Denmark began to shape its lead in GT/CC in 1976, when its Energy Research Program granted generous subsidies to renewable energies.[19] Danish renewable energy companies turned heavily toward wind power, selling that technology domestically and abroad, especially in California. In 1989, new laws required utilities to buy electricity from renewable sources and co-generation plants, and a series of subsidies and other government support boosted GT/CC through the 1990s. By 2003, Denmark dominated the global market for wind-power generator sets, selling $966 million or 79.5% of the market.[20] Denmark still gets a larger share of its energy from wind than any other country and sold $1.2 billion worth of generator sets in 2008, or 23.4% of the global market.[21] Meanwhile, Danish Vestas controls 17.8% of the wind turbine market, putting Danish companies behind Germany and ahead of the U.S., Spain, and China in that field.[22] In 2008, the Danish government's Agreement on Energy Policy sets goals of 20% of gross energy consumption from renewable sources by 2011, with incentives for de-centralized production, research, and other activity.

On the other side of Europe, Spain had a mere 979 GWh of renewable energy generation, almost all of it hydro-electric, in 1990. Yet in 2007, that same generation had risen 33-fold to 32,714 GWh, with wind accounting for about two-thirds of total.[23] A series of steps similar to those in Japan and Denmark led to this rapid rise, which has ultimately left Spain a major force in the world's solar and wind energy markets. Spain's 1980 Law for the Conservation of Energy first established subsidies for renewable energy sources feeding into grid. In 1997, the Law of the Electricity Sector guaranteed grid access for renewable sources and later laws set prices as well as targets, such as 12% of energy from renewable sources by 2010. With this support, Spain ranked third globally in 2008 in installed wind capacity with 16.8 GW and controlled 8.8% of the market for wind generator sets and 14.9% for turbines.[24] It has also been a leader in solar thermal plants, building Europe's first in 2007 and continuing to develop others.

Germany, finally, has achieved some of the broadest, most profound changes en route to a GT/CC economy. It reached its Kyoto Protocol emissions target of a 20% reduction of GHG emissions from 1990 levels in 2007, a year early. A series of polices has enable this progress, such as the 1991 Feed-in Tariff Act that required utilities to purchase electricity from any supplier on the grid. Later laws, such as the 2000 Renewable Energies Act and its subsequent updates, have guaranteed prices for renewable energies and set broad environmental targets. Germany in 2009 set even more ambitious plans for reducing overall emissions and dependence on fossil fuels.

---

[19] IEA, http://www.iea.org/textbase/pm/?mode=re&id=76&action=detail.

[20] United States International Trade Commission, "Wind Turbines: Industry and Trade Summary," July 2009, 40-41.

[21] Eurostat, "Share of renewables in gross inland energy consumption - %," http://epp.eurostat.ec.europa.eu/tgm/refreshTableAction.do?tab=table&plugin=1&init=1&pcode=tsdcc110&language=en); IEA, *World Energy Outlook*, 166; ITC, 40-41.

[22] ITC, 3.

[23] Pablo del Rio Gonzalez, "Ten years of renewable electricity policies in Spain: An analysis of successive feed-in tariff reforms," *Energy Policy* 36 (2008):2917-2929, 2918.

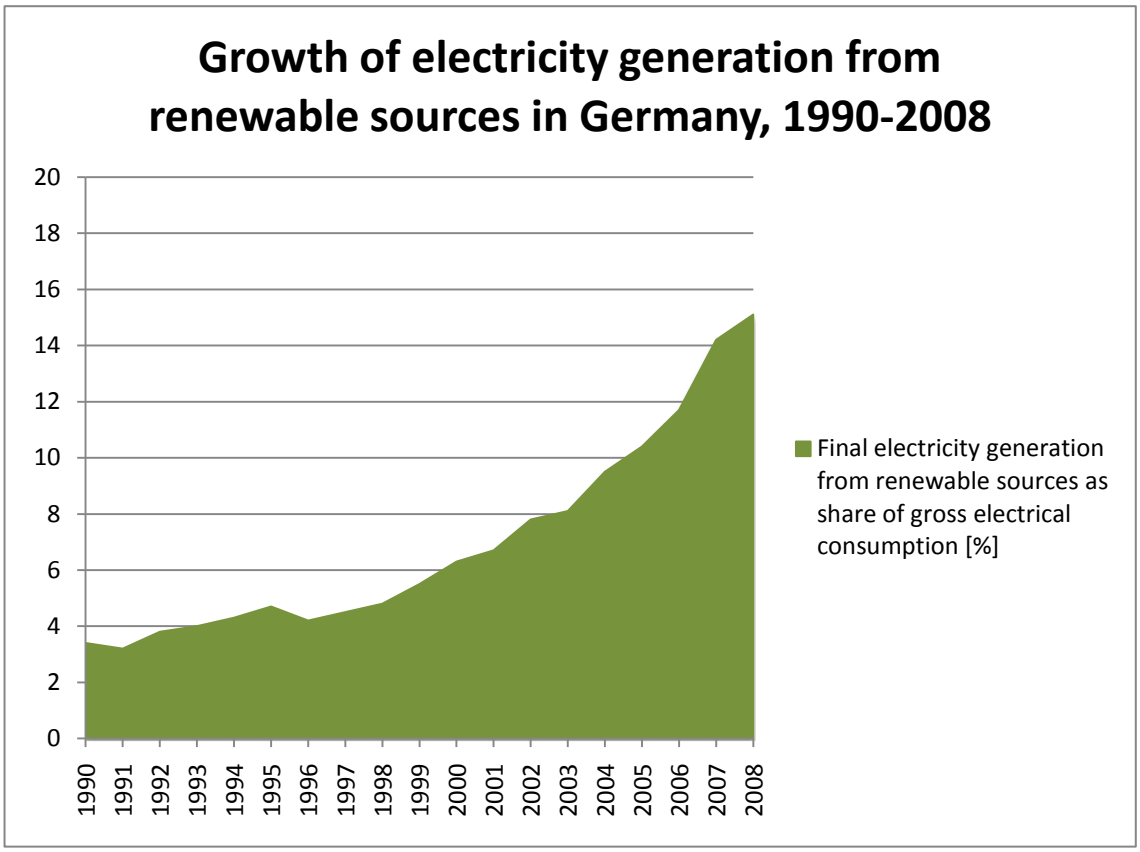
[24] Federal Ministry for the Environment, Nature Conservation and Nuclear Energy, "Renewable Energy Sources in Figures: National and international development," 2009, 55; ITC, 3, 40-41.

The German Government's targets at a glance:

- **Greenhouse gas emissions are to be cut by 40 % by 2020 compared with 1990 levels. By the end of 2007 Germany had already achieved a reduction of – 21.3 %.**
- **Energy productivity is to be increased by 3 % per annum. This means that by 2020, energy use will be twice as efficient as in 1990.**
- **The proportion of renewable energies is to be continuously increased to account for**
  - **18 % of final energy consumption by 2020, compared with around 10 % today;**
  - **At least 30 % of gross electricity consumption by 2020, compared with around 15 % at present, with continuous further expansion thereafter;**
  - **14 % of heat energy demand by 2020, compared with just under 8 % today;**
  - **By 2020, the proportion of biofuels is to be increased to such an extent that greenhouse gas emissions will have been reduced by 7 % by 2020 compared with the use of fossil fuels, corresponding to an approximate energy share of 12 %;**
  - **50 % of energy consumption by 2050.**
- **The share of electricity production derived from cogeneration (CHP) is to be doubled to 25 % by 2020.**[25]

In 2008 in Germany, revenue from construction of renewable energy facilities was 13.1 billion Euros (approximately $19.7 billion) and from operation was 15.7 billion Euros ($23.6 billion), representing approximately 278,000 jobs in all. The total revenue from these two activities increased 188% relative to 2003.[26] **Meanwhile, the German government's Market Incentive Program, through grants and other incentives, encourages renewable energies by direct funding, which attracts additional investment. From 2000 to 2008, 1.2 billion Euros of direct funding attracted an additional 8.6 billion Euros of outside investment, with government funding for renewable energy R&D directed mainly to solar and wind.**[27] **The results have been a near quintupling of electricity generated from renewable sources since 1990. In contrast, U.S. government subsidies totaled $29 billion from 2002-2008 for renewable energies, more than half for corn ethanol, which paled in comparison to $72 billion in subsidies for fossil fuels.**[28]

[25] Federal Ministry, 10.
[26] Federal Ministry, 29-30, 31.
[27] Federal Ministry, 39, 42.
[28] Environmental Law Institute, *Estimating U.S. Government Subsidies to Energy Sources: 2002-2008*, 2009, http://www.elistore.org/Data/products/d19_07.pdf.



Source: Created from data in Federal Ministry for the Environment, Nature Conservation and Nuclear Energy, "Renewable Energy Sources in Figures: National and international development," 2009, 16.

What you see when reviewing different countries' strategies is policy variation customized to local conditions but built upon a consistent pattern of core features that includes protections to control consumer costs and mitigation for windfall profits to any players. Simplicity is important to keep public administration costs low and company and individual transaction costs minimal. Consistent policies, gradual amendments to update, and stable supports (whether direct investments or tax incentives) are essential to encourage equipment manufacturers to innovate and to mass produce. Clear and consistent signals also reassure investors that markets will be relatively predictable within adequate time frames for generating returns. In summary, successful government policies appear to include key stakeholders and set ambitious targets, and then address concerns about price-gouging and the factors that typically drive innovators and companies away: instability, uncertainty, and inconsistency.

The U.S. can catch up, but when other countries are working from 20 year-plus guaranteed grid access for renewable energy producers in Spain and Germany (starting in 1991 in Germany) and well-established Spanish Feed-In Tariffs (TIFs) that built on German and Danish examples established well over a decade ago, it suggests the magnitude of the catch up challenge. These countries jumped in early, learned and adapted, and can now act faster and more effectively to build their CT/CC going forward. For the huge and rapidly

growing markets for GT/CC in India and China, the U.S. faces governments quickly moving to protect and support fledgling industries that will produce clean cars and public transportation technologies to address pollution impacts, clean energy production (to offset reliance on dirty coal), and the state of the art green components and systems to address the many development and pollution/health problems they know they must solve.

Final Thoughts

The economic growth paradigm and accompanying common knowledge that told us growth had to come first, followed only much later by investment in environmental and health protection (the path of western industrialized societies) will not be sufficient for India and China. I tell my MBA students that given the pace of innovation in those countries around clean commerce goals, the U.S. will be buying most of its clean technology solutions from Indian and Chinese companies in 10 years.

I would also suggest that the U.S.'s geopolitical decline, should it come to pass, will be reflected in our unwillingness to step up to the GT/CC challenge that current population, resource, pollution, and technology development conditions impose.

I am not an advocate of government regulation unless the private sector lacks the ability to provide for the public good. Unfortunately, companies trying to move toward GT/CC, while admirable, are in a race against the cumulative decisions of firms and individuals that continue to erode the commons that is our ultimate source of all wealth, social and financial.

We tend to think of the commons as natural systems (air, water, or land); we might want to consider adding our children's bodies to that collective commons. The Centers for Disease Control extensive research on contaminants in human blood, immune, and reproductive systems suggest that this century long industrial experiment that clearly has had decisive negative influences on our ecological systems and atmosphere, is also at work on the human body and children's health. Are we surprised?

The last thing I want to see is unnecessary regulation. I work with private sector innovators and emphasize the amazing capacity of markets and entrepreneurial forces in society to create the changes we need to see. But this activity must be framed with enabling and supporting policy that sets the rules and provides consistent and intelligent guidance so that markets and human ingenuity can do the rest.

In addition, let us keep in mind, in the polarized and ideologically laced discussions that pass for policy debate, that there are no purists. State subsidies and consistent long-term government support for fossil fuels played a large part in giving us the energy and materials system we live with today. Subsidies, just in recent years alone, explain why GT/CC activities remain vulnerable and investment capital moves slowly.[29]

Can the U.S. build a GT/CC strategy? Through insufficient investment and lack of policy leadership the U.S. continues to lose ground in its learning pace and its domestic experience to countries willing to back their companies with capital and create mutually reinforcing incentives to mobilize citizen behavior, corporate investment, education, and state decision

[29] Environmental Law Institute, *Estimating U.S. Government Subsidies to Energy Sources*.

making. While the hesitancy of the U.S. to create industrial policy to lead in GT/CC is historically understandable, other countries without our political and ideological history (and gridlock) have put policies in place. First we must get our own house in order. It is only then that we will have built the necessary platform for leadership in world trade.

The challenge is straightforward, if ambitious. Future prosperity depends on economic development solutions that address poverty and extreme disparities in income distribution while simultaneously delivering on job creation, skill development, and education for the future. Industrial and commercial activity that fails to actively support provision of clean, healthy products, and clean air, water, shelter, transport, and food, by definition undermines that prosperity. Fortunately the know-how and tools are now available in the form of GT/CC practices and innovation. If the Subcommittee members would like to know more about these topics, this is what I teach, and I would be happy to pass on that information as well.