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Energy and Ecology Futures: Green, Clean and Dollar Smart
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As I pondered the twin themes of energy and ecology and contemplated this gathering of business leaders, environmental practitioners, and policy pundits, my thoughts kept shifting to a broader context. Behind quests for energy security and environmental protection loom a larger central question: how might we maintain and enhance quality of life?

That question involves multiple dimensions that include meeting human aspirations for shelter, heating, cooling, convenience and leisure, personal mobility, and economic dynamism. It includes enhancing health, of which environmental quality is an important link. It includes preserving, protecting, and maintaining natural landscapes, flora and fauna—the places that sustain us spiritually, socially, and economically.

The search for a new energy future is a quest to fulfill those aspirations. Investments in environmental protection are a part of that quest. Each minute, each and every minute, we pay nearly $200,000 for imported petroleum. Our energy production and use are implicated in greenhouse gas emissions and climate change. Our energy production is transforming landscapes. Energy use, energy efficiency, and energy conservation are, thus, universal concerns. This concern has moved beyond the realm of manufacturers seeking to reduce costs to encompass the realm of policy, politics, and society as we seek to meet broad social, environmental, and economic goals.

Before addressing the political economy of where we are going, I'd like to reflect on where we are. Let us use the energy context to illustrate our past and present journey.

Looking at the past 30 years, despite increases in total energy use, energy efficiencies of individual products are significant.

For example, today's refrigerators use one-third less electricity than 30 years ago. From 1973 to 2001, the U.S. economy grew 126 percent, while energy use increased 30 percent. During the 1990s alone, manufacturing output climbed 41 percent, but industrial electricity consumption grew 11 percent. From the dawn of the industrial era to the present, we have witnessed continuous efforts to do more with less—to dematerialize, climb up a clean fuel ladder, and conserve energy.

We see technological wonders that use far fewer resources—and less energy—to do familiar tasks. A single CD holds 90 million phone numbers, which can replace—at a phone company—5 tons of phone books. Or consider fiber optics. Sixty-four pounds of silica yield a communications network that carries 40 times the messages of a cable made from one ton of copper. Or consider trucking: the advent of Global Positioning System technology allows one trucking firm to avoid 4 million miles of driving per year. These innovations yield phenomenal savings in both resources and energy.

I call these innovations the viridian verge—the linking of economic action with environmental benefits. What is the bottom line of this brief technological tale?

We have made conservation progress, but conservation is a journey not a destination, to borrow a much-used phrase. That journey is complicated by an ever-growing population base and associated consumption requirements. It is complicated by the recognition of a broader universe of impacts that now include greenhouse gases.

The good news is that there is still much untapped potential for reducing environmental impacts at the intersection of energy, the economy, air, lands, and water. Opportunities for environmental entrepreneurship unfold along two dimensions—technological innovations and institutional innovations.

The role technological innovation plays in adding value in our lives is well recognized. Yet let us stretch our imagination beyond the traditional universe of "green" technologies. Let us

explore a bigger set of possibilities. Adapting from a phrase of management guru Peter Drucker, environmental opportunities lie "anywhere and everywhere" rather than in a few "green" technology categories.

Consider a few examples that fall outside of the traditional recycling, remediation, and renewable energy boxes.

A decade ago, at one refinery, an oil company embraced "Nature's Capital" by creating wetlands to treat its wastewater rather than continuing to rely on the prescribed mechanical treatment system. The wetlands purification system required one-third the installation costs of traditional mechanical treatment systems. It cost $30,000 to $50,000 per year for maintenance in contrast to ten times that amount for maintenance of traditional mechanical treatment systems. The wetland purification system produced better water quality—and created habitat that became home to some 200 species.

Or consider a Dutch flower grower who shifted from traditional soil medium and, instead, began growing flowers in a rock wool medium with water circulating through the medium. Through this system, the nursery could reduce water use through recirculation. It could reduce chemical use dramatically through their refined and controlled application in the circulating water. Plant quality improved because variability in growing conditions was reduced. Labor costs declined because harvesting flowers from containers on platforms was easier than harvesting from ground-level flower beds.

Take another example: Hitachi six-screw washing machines. The machines enhance ease of disassembly and remanufacturing. They require 33 percent less time to produce because of fewer parts. They require less servicing for the customer because of the reduced number of moving parts.

These industries—oil refining, flower growing, and washing machine manufacturing—fall outside traditional "green" categories. Yet these are all examples of environmental innovation. Similar opportunities lie among the many goods and

services in the marketplace and among activities undertaken by governments.

But let us move from technological innovation to institutional innovation—*an oft-neglected dimension of environmental entrepreneurship*. For environmental entrepreneurship, new institutional arrangements that improve environmental and energy performance fall into several categories.

These innovations include new relationships between manufacturers and suppliers through "green performance contracts." For example, Saturn used to buy paint by volume. Under this arrangement, paint suppliers had little incentive to make more efficient paint—paint that would adequately color cars but use less "stuff." Saturn introduced a green performance contract through which its paint suppliers get paid on the basis of the number of cars painted rather than volume of paint purchased. Under this arrangement, paint suppliers have an incentive to develop more efficient paint. They also have an incentive to work with Saturn to reduce overspray, which wastes paint.

These new relationships also include new interactions between producers and customers—for example, "green building" management contracts in which builders or building managers receive a portion of costs saved from energy conservation. At Interior, with small, remote locations, we pioneered contracts with energy efficiency firms to enhance conservation at a cluster of dispersed, small-scale sites.

Institutional innovations also include other new producer and customer relationships. One company introduced "carpet tiles" and carpet tile leasing, whereby companies lease floor covering rather than buy it. When individual carpet tiles wear out, they can be replaced without discarding the whole carpet.

Another institutional innovation centers on new relationships between a company and its host community. Some companies have developed "Good Neighbor Compacts" through which they work with communities to develop agreed upon performance

goals. The goals often go beyond basic compliance with state and federal regulations. These compacts help enable companies to continue or expand production and overcome "not-in-my-backyard" predispositions.

We are also seeing new relationships among producers through waste exchanges and "byproduct synergy" contracts. Through these relationships, one company's waste becomes another's feedstock. In Texas, a mini-steel mill generated fly ash as waste, which, in turn, it sold to a Portland cement company as a feedstock.

These new institutional and market contracting arrangements are significant, because they affect incentives. They affect motivations of energy and materials users to seek out ever-more efficient technologies and practices that reduce environmental impacts.

Opportunities abound to better meet this Nation's energy needs—through conservation and lower-impact technologies, as well as through new management techniques.

But let us think big—and differently. I spent nearly eight years at the Interior Department. The Department manages one in five acres of the United States. Through its Bureau of Reclamation facilities it supplies drinking water to 31 million people. It provides water to farmers who generate two-thirds of the Nation's vegetables. The Department manages offshore & land leases that generate a third of the Nation's energy production that brings $10 - $20 billion in revenues for the Nation's treasury. To accomplish these and other responsibilities, the Department has 165,000 facilities at 2,400 locations across the Nation.

In many ways, Interior—though a public agency—faces constraints and opportunities at the intersection of the economy and the environment that mirror those of private sector. That intersection presents opportunities for Interior to engage in environmental entrepreneurship illustrative of possibilities within the broader economy. These opportunities include "greening" of buildings, using permeable surfaces in the built

environment, and enhancing energy efficiency, among many other possibilities.

At Interior, we saw new institutional relationships emerge to enhance what I call cooperative conservation. For example, in the boot heel of Arizona and New Mexico, ranchers have created a grassland bank that conserves land while also creating a "bank" of forage accessible during periods of drought or other special needs. The Sonoita Valley Planning Partnership, the Blackfoot Challenge, the Northwest Marine Straits Initiative, and other partnerships are engaged in landscape-scale conservation that transcends jurisdictions and land boundaries, both public and private.

These innovations in shared governance align the decision setting with the cross-jurisdictional scale of the problem sets. These efforts are invoking new forms of network or shared governance through "board of trustee" models or other institutions that enable agencies and the public to work together and transcend governing "silos."

Consider other institutional and market innovations. Financial entrepreneurs in the Northwest are trying to develop new sustainability financing tools. Specifically, they have sought legal changes to allow public activity bonds to be spent on conservation easements to create sustainable forestry investments. The selective logging under sustainable practices would create revenues to pay off the bonds. The concept would require a change in the tax code. But the idea, nonetheless, exemplifies a sort of environmental entrepreneurship.

A few months ago, celebrated author Thomas Friedman dubbed 2008 as the year the Great Disruption began. Eying years of economic growth, eying disparities between rich and poor nations, eying so much consumption of stuff, Thomas Friedman opines that "We can't do this anymore." He recycles a theme that has recurred every so often since Malthus first warned of too many people consuming too many resources.

Other pundits judge the world's economy in terms of banking and credit and access to capital. Friedman talks of even bigger cataclysms of economy and the environment. We are, he says, simply running out of stuff—depleting the "natural capital" of the planet.

I think Friedman offers the wrong diagnosis for today's profound economic woes. He misses the dynamic processes in a competitive marketplace that enable us to "do more with less." As far back as Henry Ford's first assembly lines, engineers measured and tinkered to reduce costs by reducing waste. Even something as prosaic as a coke can has gone through multiple evolutions, so that the once hard to crush metal can, now, by me, can be squashed and torn into two pieces. Why? Because it now takes just 28 pounds of metal to make 1,000 cans where, 40 years ago, 1,000 cans required 168 pounds of metal.

Friedman's diagnosis may be wrong. But he ends with an important admonition—or perhaps a cheer. He cheers for an economic assessment that sees opportunity in nurturing Nature's Capital. Natural landscapes—wetlands and sea marshes, watersheds of free-flowing rivers and streams, forests, grasslands, even urban parks and roadside tree canopy—have multiple benefits for human communities. These natural systems purify water; moderate temperatures; absorb pollutants from the air; provide habitat for bees that pollinate crops; and protect coastal communities from storms.

Yet the connection between these services and the natural world around us is often invisible—and neglected. This neglect results in underinvestment in environmental protection and increased impacts from land, water, and coastal transformation.

With ecosystem degradation come corresponding losses of natural system functions and their benefits to human communities. These losses carry hidden energy costs. Natural systems provide for the most basic of human needs—services that enhance safety, health, and economic opportunity.

The City of New York invested over $1.5 billion to protect and restore the Catskill Mountain watershed, a web of natural systems purifying the city's water supply, rather than spending up to $9 billion on filtration plants. Investing in Nature's Capital saved the city money and enhanced habitat. But the investment also translated into avoided energy use that mechanical water filtration systems would have required.

The nonprofit organization, American Forests, evaluated the extent of tree canopy in cities such as Houston, Roanoke, and Atlanta. Houston lost 16 percent of its tree canopy over the last three decades, translating into a loss of annual air pollution "removal services" pegged at $38 million and an annual loss of stormwater management services of $237 million. The loss also meant increased energy usage. Consider figures for one city—San Antonio. Lost tree canopy in San Antonio over a 15-year period is estimated to equate to a $17.7 million increase in residential summer energy costs per year. These examples highlight the significant services natural systems provide to human communities, their health, safety, and prosperity.

Failure to recognize these services results in decisions that diminish, degrade, and even destroy natural assets. The result of this destruction can be increased environmental harm, higher costs to provide services such as water filtering through mechanical engineering alternatives, and foregone benefits of energy savings and community safety.

The 20th century was a time of paving over our cities. The 21st century will, I believe, be a time of re-creating natural landscapes, natural urban streams, and other permeable landscapes.

This trend highlights intersections of biology and engineering. It highlights the relevance of materials innovations in infrastructure and buildings.

Buoyed by the expanding academic research on ecosystem services, some recent public policy initiatives have begun to acknowledge the economic value of natural systems through the

health, safety, and other resource benefits they provide to communities. The most recent *Farm Bill* requires the Department of Agriculture to develop a framework for measuring environmental service benefits from conservation and land management, anticipating participation by farmers, ranchers and forest landowners in ecosystem service markets.

The Environmental Protection Agency has allowed watershed permits through which wastewater treatment plants may enter into trading arrangements with farmers who plant trees to achieve permit requirements for temperature rather than installing high-cost and energy-consuming refrigeration systems. One trade in the Tualatin River Basin resulted in payments to farmers of $6 million to plant shade trees in riparian areas, avoiding $60 million in costs to construct refrigeration systems at four wastewater treatment plants.

Let me make one thing clear. Investing in Nature's Capital offers economic opportunity. But it also is a central foundation of 21st century environmentalism and "smart energy" strategies for the Nation. Tree cover in urban areas east of the Mississippi has declined 30 percent over the past 20 years, while the urban footprint has increased 20 percent. An estimated 634 million trees are "missing" from urban areas across the United States as a result of urban & suburban development. This loss of trees and associated permeable surface area has cost cities an estimated $100 billion in increased stormwater management needs—and the accompanying energy use associated with water treatment facilities.

Many entrepreneurs and managers have explored technological opportunities for cleaner, greener futures. But there's a political dimension to a clean, green, and dollar smart future—a dimension shaped by context and challenges. I want to highlight three elements of that context that, I believe, will affect the politics and economics of energy and environmental futures.

First is water—yes, water. Moving water from where it is to where it is wanted consumes energy. We have significant opportunities to affect energy consumption by rethinking water

infrastructure and technologies. Many energy sources also require large amounts of water—or can affect water quality. Energy production, too, is linked to water. Consider that a preliminary target of 7.5 billion gallons of ethanol per year requires 30 billion gallons of water to process—equivalent to the total water needs of Minneapolis. If a quarter of the corn crop to generate this ethanol needs irrigation, ethanol will need nearly a trillion gallons of water per year—equivalent to the combined usage in all cities of Arizona, Colorado, Idaho, and Nevada.

Much energy production and use is linked to water, yet water constraints loom large. A National Research Council report concluded that abundant supplies of clean, fresh water could no longer be taken for granted—not just in the West, but across Nation.

Yet we miss big opportunities for water conservation and reuse. In most cities, potable water is used for all water needs, including toilet flushing and irrigation. One estimate puts use of city water for drinking at just one half of one percent of the total consumption of 175 gallons per capita per day.

We have witnessed burgeoning populations in Nation's driest areas. Climate change is altering the availability and timing of water. Off-stream water withdrawals in the United States are estimated at 408,000 million gallons per day, or three times the average flow over the Niagara Falls and enough water to fill the Astrodome every 2 minutes.

Energy and ecology strategies, thus, should be linked to water strategies. As we think about energy and ecology, I believe we cannot do so in isolation from contemplating water supply and quality. Are there technologies to reduce energy requirements for supplying water to communities and farms? And, as we supply energy—whether biofuels, fossil fuels, nuclear power, other fuels—how can we minimize water requirements?

More broadly, how can we sustain and improve instream flows while still meeting human needs? The experience of Walla, Walla Washington may point to better ways to manage water and

reduce conflicts. A partnership of local governments, landowners, the conservation community and others now has the authority, through the state legislature, to manage water flows.

Much more might be said of water, but I want to turn to a second context profoundly shaping our economic and ecological futures—that context is climate change. A key driver of energy economics is climate change politics. The advent of a national climate policy will affect relative costs of different energy options. But the devil is in the details. Therefore, the shape of energy futures is partly linked to the shape of the climate policy future.

Climate change will affect more than energy and the manufacturing economy. I chaired the Interior Climate Change Task Force at the Department of the Interior from 2007-2009. We examined the effects of a changing climate on lands, water, and wildlife. The changes are significant—and *not* a matter of models and theory. The permafrost in the Arctic is now thawing; sea ice is melting faster than even the most aggressive models projected; the fire season is 78 days longer than in the past; precipitation patterns are altering.

Prudent land and water management requires that we understand these impacts—and consider them in making management decisions. For example, understanding these changes is important as the Bureau of Reclamation sets its annual operating plans for water delivery, or communities plan coastal infrastructure, or energy firms build infrastructure in Alaska, or wildlife agencies set aside wildlife preserves.

A third contextual element in thinking about our energy and ecological futures is land use, land fragmentation, and land transformation. Many alternative energy sources—photovoltaics, wind, ethanol, and other biofuels—are very land transforming. So, as we pursue clean energy, I think we need to broaden consideration of what's green and broaden how we think about generating energy. Yes, carbon footprints matter. So, too, do landscape footprints and wildlife impacts. We need

only look at the Mojave Desert and the current scramble to site solar and wind projects to anticipate looming land use challenges. These challenges need not preclude investing in alternative energy systems. But I think we need landscape-scale horizons for Bureau of Land Management decision making to make possible clustered development, wildlife corridor protections, and synergies in infrastructure.

There is an old Chinese adage that observes: "in challenges reside opportunities." My appeal to those gathered is how to minimize our environmental footprint on landscapes, using a holistic rather than unidimensional environmental framework.

Smart energy and environmental futures confront other challenges. Among those challenges are institutional procurement practices. Sometimes, energy efficient technologies and practices generate lifecycle savings—but cost more upfront. Many firms and governments acquire goods calculating relative purchasing costs, not long-term or life cycle costs. Success, therefore, of energy efficient technologies may hinge as much on changing contracting rules as on the performance merits of the technology.

As we move toward new energy futures, I think we must be wary of legislated technology prescriptions. Mandating one good idea may preclude other new ideas. The EPA has numerous voluntary and mandatory energy efficiency standards for appliances, lighting, and other products. EPA also has many certification programs. Regulations, standards and certifications can stimulate results, but can stifle creativity, too.

What, then, are the challenges to environmental entrepreneurship? First is the marketplace itself. While opportunities for greening are infinite, attempts that assume buyers are willing to pay a premium for environmental improvements in their goods and services may find expectations unfulfilled. Just a small percentage of the buying public is willing to pay a premium for environmental attributes. Goods or services with environmental attributes, to be widely embraced,

must be cost competitive with alternatives to flourish. In today's economy, this constraint is especially compelling.

Second are rules constraints. The Resource Conservation and Recovery Act hazardous waste definitions stand in the way of more waste exchanges, for example. The Endangered Species Act as currently implemented is not well suited to multi-species, landscape-scale conservation. The Clean Water Act, as implemented, is not well structured to address nonpoint source pollution. None of the current national environmental statutes is well structured for holistic thinking—except, perhaps, potentially the National Environmental Policy Act.

Third are information constraints. Performance contracts require good baseline information and good metrics that specify what constitute good practices and good results. Yet we often lack that information.

Tax law, too, can be a constraint. The current code does not permit the sort of environmental activity bond envisioned by some foresters engaged in sustainability practices. And tax code treatment of leasing versus capital asset purchases can make "green performance leasing" appear more expensive than direct asset purchasing.

Yogi Berra opined that: "the future ain't what it used to be." Perhaps in a more sophisticated—and less ironic—way, scholar Richard White made a similar point when he wrote that: "All the context in the world doesn't explain tomorrow, which is where you always end up."

I have offered some context. I have summarized some current circumstances, challenges, and trends. Yet "stuff happens." So I speak not as Cassandra peering into a crystal ball, but as a perennial optimist that human ingenuity will lead us to a better future.