

# **A Blueprint for Today's Sustainability**

## **Sustainability Initiatives Across Key Sectors**

By John Lash

Amidst all the hype about going green and sustainability, this paper sets out to answer the question "What is corporate America actually doing to address climate change?" Not just how companies talk-the-talk, but more importantly, what kind of programs are being put in place to walk-the-talk. The underlying purpose for this study is to identify the areas that have the biggest potential to make a real impact, from a combined economic and environmental perspective. With this in mind, sustainability initiatives industry wide were mapped out and analyzed as to which areas deliver the most value throughout the entire product life cycle. The ensuing patterns expose a common set of programs found across industries with the right mix of financial and environmental benefits to be successful. In short, they reveal a blueprint for today's sustainability.

This paper is the result of a four-month self-funded study and is being shared with the community as a resource to inspire the adoption of sustainable practices by both individuals and businesses.

### ***Introduction***

While concerned groups have been making the case for global warming and environmental responsibility for years, it has only recently crossed over into the main stream. Popular acceptance is in part thanks to Al Gore's "An Inconvenient Truth" which tapped viral marketing to spread the word that global warming is a reality. Whether you agree fully with the documentary or take it with a grain of salt, the message resonated with the public and set the stage for consumer demand of environmentally friendly products and services. At the same time, the science behind global warming and man's role in accelerating it is no longer being refuted. The academic and business communities came together with a single voice, including holdouts such as Exxon that until recently had refuted and cast doubt on the science. The emergence of an awareness that something needs to be done, combined with a collective view on the science of global warming, essentially created a wake up call around the globe.

CEO's, both as individuals and as leaders of their companies, heard this wake up call and the current sustainability movement was born. Today's sustainability embraces corporate social responsibility and environmental awareness built on the foundations of increasing the bottom line and brand value. Unlike the eco-movement in the Carter era, today's sustainability does not ask consumers to change their habits or make do with less, but to expect more for less. This message appeals to the existing environmentally sensitive consumer and makes it easy for others to "go green". Corporations win with positive contributions to the bottom line, a sense of doing the right thing and an opportunity to increase brand value/loyalty. Embracing the new sustainability is good for the environment, strengthens companies and gives them competitive advantage.

### **Four Tenets of Today's Sustainability**

From ten thousand feet, the new sustainability is all about being environmentally friendly and making money. This sounds great to CEOs thinking about sustainability, but what are companies actually doing to achieve this? Analysis of sustainability initiatives industry wide reveal that the backbone of most programs is based on the four Tenets of Awareness and Transparency,

Efficiency Improvements, Innovation and Mitigation. While actual implementations are business specific, these Tenets provide a framework for CEOs to start with.

**Consumer Awareness and Transparency** communicates the value of your sustainability initiative and is key to building brand equity. Transparency offers accountability to the program and avoids “green-washing”. In addition to getting out the word, awareness programs are often promoted as educational, providing a series of sustainability best practices to improve industry at large. Whether you view this through a lens of being altruistic or self-serving, the net result promotes and advances sustainable practices.

**Efficiency Improvement**, how to do more with less, is a central theme in most sustainability programs. Efficiencies improve products or processes, typically without making major changes to the underlying product or technology. Modifying engine design to be 20% percent more efficient is an example of product efficiency, whereas redesigning packaging to reduce waste or transporting components and finished products more efficiently are examples of process efficiency. The effects of efficiencies are additive, each contributing to the sustainability goals of the company, driving bottom line and creating potential for increased brand value.

**Product Innovation** is often more challenging than efficiency enhancements because it results in fundamental changes to products and processes. Innovation tends to have a higher barrier to entry than efficiency programs, requiring ideas that challenge the status quo and usually significant R&D and marketing investments. The risks of failure for both product development and ultimately customer acceptance are higher for innovations, but so too are the potential rewards. Developments of thin module photovoltaic (TMPV) solar cells and algae-based bio-diesel, both with potential to significantly change the economics of renewable energy, are examples of innovation.

**Carbon Mitigation** offsets green house gas (GHG) emissions through projects that remove carbon from the atmosphere. The Kyoto Protocol's cap-and trade mechanism created the framework for trading carbon allowances as a way for companies to meet mandatory GHG emissions targets. It also paved the way for a voluntary carbon offset market targeted to companies without mandatory requirements or those seeking to be carbon-neutral. Carbon-neutral status is also becoming popular for individuals with a number of sites and affinity credit cards catering to this desire.

## ***Sustainability Initiatives Across Key Sectors***

Sustainability initiatives have blossomed in every sector of the economy. Generally speaking, the depth of a company's sustainability program depends first and foremost on senior management's commitment level, specifically the direct involvement of the CEO.

Underlying each initiative is a combination of some or all of the four Tenets of Awareness and Transparency, Efficiency Improvements, Innovation and Mitigation, with companies in each sector sharing common areas of interest. The sectors covered in this article include:

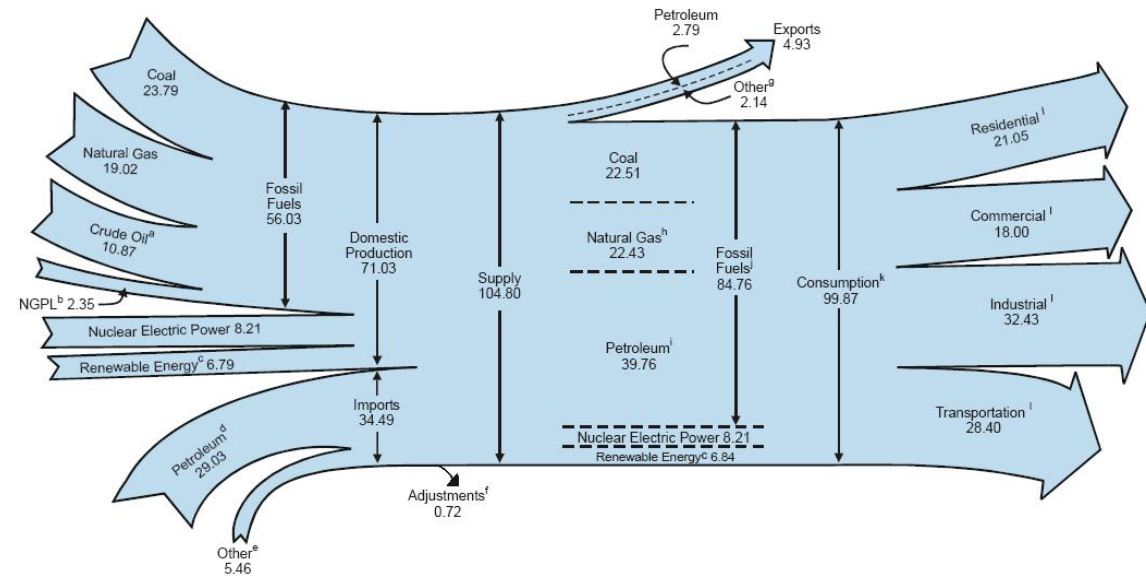
- Energy
- Materials
- Transportation
- Retail
- Information Technology

## Energy Sector Initiatives

Energy is at the foundation of the economy and is common to every product or process whether physical or virtual, so it seems a review of sustainability initiatives should start with the energy sector.

Fossil-fuels account for 85% of the energy consumed by the US, with less than 7% coming from renewables <sup>1</sup>. This provides an excellent landscape for sustainable energy opportunities.

### US Energy Flows (Quadrillion BTUs)<sup>1</sup>



Hydro electricity has long been a staple in modern power production and until recently was the only renewable source in a field dominated by fossil fuels. It currently accounts for more than 90% of electricity that comes from renewable sources<sup>2</sup>.

## Renewables and Alternatives

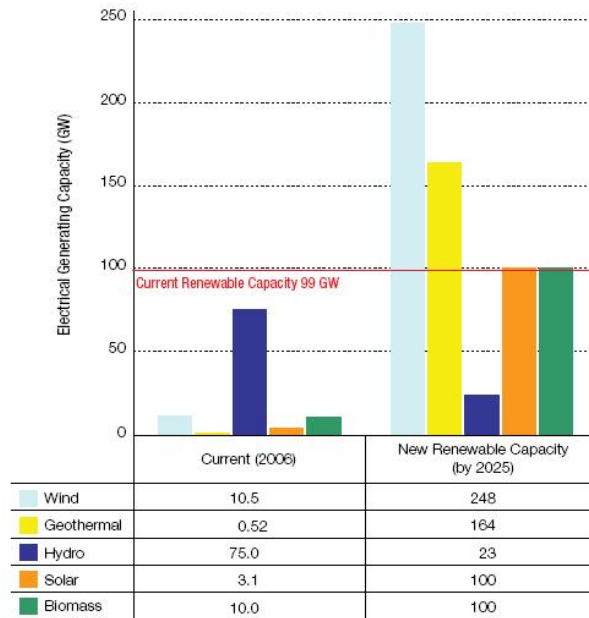
Renewable and alternative energy initiatives are gaining popularity. The EU has taken a lead, committing to the objective of using renewable energy to meet 21% of its domestic energy consumption by 2010 and has confirmed they are on target. While some member countries are behind schedule, others such as Germany are ahead of their national objectives, due in part to subsidies such as set feed-in tariffs guaranteeing rates for renewable electricity<sup>3</sup>. Closer to home, US Congress passed the Clean Energy Act earlier this year, transferring nearly \$14 billion in tax breaks for oil and gas to renewable energy<sup>4</sup> and are in the process of extending a number of important renewable subsidy programs.

Meanwhile, green power options are now readily available to consumers from a growing number of utilities. ConEdison offers GREENpower (comprised of 35% wind power and 65% small river hydropower) and WINDpower (100% wind energy) in response to customer demands for environmentally-friendly energy options<sup>5</sup>. Corporations and homeowners are also purchasing and installing their own renewable energy generation capacity as part of a plan to offset their

carbon footprint and/or reduce their dependency on the grid. Google has recently completed one of the world's largest corporate solar installations supplying its campus with 1.6 mW of capacity<sup>6</sup>.

The long range outlook for renewable energy capacity is promising. In the US alone, renewable energy is predicted to grow from 98 gW in 2006 to a total of 645 gW by 2025<sup>7</sup>.

### Forecasted Renewable Growth by Energy Source<sup>7</sup>



Popular renewable and alternative energy sources include:

- **Wind** installations range from large utility-scale wind farm complexes, both on-land and offshore, to small individual systems. Global wind capacity increased by 25% in 2006 exceeding 74 gW<sup>8</sup>. The US market is expected to grow from 9.8 gW in 2006 to 31.6 gW by 2010<sup>8</sup> and to 258 gW by 2025<sup>7</sup>.
- **Solar** offerings range from utility-scale concentrated solar power systems to commercial and residential solar photovoltaic (PV) systems. Installed US solar capacity is considerably smaller than wind, with reported figures ranging 100 mW<sup>9</sup> to 3.1 gW<sup>7</sup>. The market is expected to grow rapidly through 2015 to reach capacity of 113 gW and adjust to a constant pace, reaching 164 gW by 2025<sup>7</sup>.
- **Bio-Fuels (Biomass)** are liquid fuels created from bio-feedstocks. Popular first generation fuels include ethanol (corn, sugar, cellulosic) and bio-diesel. Earlier this year, President Bush called for an increase in the US Renewable Fuel Standard to include 20% bio-fuel, approximately 38 billion gallons, by 2017<sup>10</sup>. The Department of Energy Advanced Energy Initiative calls for replacing 30% of the current gasoline with biofuels by 2030<sup>7</sup>. The EU had a similar call with a bio-fuel target of 20% and mandatory floor of 10% for each member country by 2020<sup>11</sup>. The US produced 4.9 billion gallons of ethanol and 226 million gallons of bio-diesel in 2006. Europe was the leader in bio-diesel production accounting for 90% of global capacity<sup>12</sup>.

- **Bio-Gas (Biomass)** from natural decay and anaerobic digesters includes landfill methane, gas from wastewater treatment plants and manure digesters. Resultant biogas can be fed into the natural gas grid or can be used directly in power generation. Combustion of naturally occurring biogas has the added environmental advantage of converting a GHG with a Global Warming Potential (GWP) of 23 to energy and CO<sub>2</sub> (GWP of 1). The world biogas market was \$1.4 billion in 2006 and is expected to exceed \$17 billion by 2020<sup>13</sup>.
- **Water Power** encompasses traditional hydrostatic energy and more recently hydrokinetic energy (tidal, current and wave energy) and ocean thermal energy conversion. Conventional hydrostatic production, such as power generation at the Hoover Dam, harnesses the potential energy of a body of water because of its relative height. In contrast, hydrokinetic production harnesses energy possessed by a body of water because of its motion. Ocean thermal energy conversion harnesses energy from the ocean's natural thermal gradient. Although hydro electricity has traditionally been the largest source of renewable energy, water power is forecasted to grow modestly from 75 gW capacity in 2006 to a total of 98 gW by 2025<sup>7</sup>.
- **Geothermal** harnesses the earth's geothermal energy from various potential sources. Shallow hydrothermal sites, where natural fractures in the earth's crust produce hot water, are currently the most popular location for geothermal power generation. Co-production from oil and gas wells take advantage of hot water found in wells, traditionally seen as a costly nuisance to oil companies, to create energy. Deep geothermal or engineered geothermal systems (EGS) create man-made fractures in the earth's crust through which water is forced deep underground, heated and retrieved for processing. While EGS is by far the most complicated of the three scenarios, it is being promoted as a virtually unlimited source of domestic energy. Geothermal energy in the US is forecasted to grow from 2.8 gW in 2006 to 100 gW by 2025 and in excess of 260 gW by 2050<sup>14</sup>.
- **Fuel Cells**, while not a renewable source of energy, offer an electricity production alternative to traditional combustion. Fuel cells generate power by chemically converting hydrogen in an electrochemical cell, resulting in a clean energy that is 2-3 times more efficient than combustion<sup>15</sup>. As of Nov 2006, thirteen fuel cell manufactures offered commercial products in the US for primary, auxiliary, emergency and mobile power generation applications, as well as bus/lightweight-vehicle propulsion and battery replacement<sup>16</sup>.

Government subsidies play an important role in promoting the wide scale adoption of any strategic technology, providing incentive as the market develops and achieves economies of scale. Renewables enjoy both federal and state level incentives in the US. Similar programs are also popular in other countries, including EU members and Japan.

The subsidy programs are working and the cost of renewables is becoming increasingly competitive with conventional energy. Some sources such as wind are already competitive, even without the subsidies. The prices are expected to further drop as the markets begin to enjoy real economies of scale and further efficiencies.

### Typical Costs per kWh for Energy Sources (without subsidies)

Source	Price Range (cents per kWh)
Wholesale rates	4 - 5¢ <sup>17</sup>
Landfill Gas	5 - 10¢ <sup>18</sup>
Hydro	5 - 20¢ <sup>19</sup>
Wind	3 - 4 ¢ <sup>20</sup>
Solar	21- 47¢ <sup>21</sup>
Geothermal	3 - 5¢ <sup>22</sup>

Last year saw demand outstripping supply in both solar and wind markets, delaying installations and causing inflationary prices. Limited silicon availability and priority of computer chips over solar resulted in significant backlogs for solar cells. To address this, the market responded with plans to dedicate silicon capacity for solar and increase capacity threefold by 2010. Likewise, wind energy capacity is set to grow quickly with key suppliers stepping up production to meet strong demand.

### Fuel Flexibility, Storage and Portability

The flexibility of an energy source and its ability to power different applications help define its value as an alternative fuel. The value matrix includes the state of the resulting energy, consistency of its supply, the ability to regulate/control energy generation and the ease of storing surplus energy.

### State, Consistency, Regulation/Control and Storage for Renewable Energy Sources

Source	State	Supply Consistency	Level of Control & Storage	Description
Hydro	Electricity	Good	Good	Can control electricity output by opening/closing the dam
Solar	Electricity	Variable - Depends on cloud cover	None	On during the day and off at night; power output depends on weather conditions.
Wind	Electricity	Variable - Depends on wind	None	Power availability and output depends on wind conditions
Ocean	Electricity	Mixed	None	Tidal systems consistent while wave systems depend on weather conditions
Geothermal	Electricity	Excellent	None	Heat is always present whether it is used for generation or not
Fuel Cell	Electricity	Good	Limited	Can turn on/off utility-scale fuel cell but it tends to effect stability and life of the cell
Bio-Fuel	Liquid	Good	Excellent	Excellent method to store energy. Natural for internal combustion engines
Bio-Gas	Gas	Good	Medium	Gas can be compressed or combusted

Most of the current renewable and alternate energy sources result in the generation of electricity. A major challenge of electricity generators is managing peak demand to create as flat as possible a demand profile. Once generated, free electrons must be consumed, traded/sold or stored for future use. While liquid fuels can be cost effectively stored in tanks, there are currently no cost effective equivalents for electricity. The relative cost of battery systems is hundreds to thousands times that of the generating the electricity in the first place, making large scale storage of electricity economically unfeasible, even with the least expensive flow battery systems. Other approaches for large-scale electricity storage include hydro pumping and air compression. Hydro pumping converts electricity to potential energy by storing water in a dam-controlled reservoir. Air compression systems store energy by pumping air into large underground caverns systems.

New developments in large-scale electricity storage are required to properly exploit the generation-to-consumption cycle. The need for effective storage techniques is especially important for renewable sources. Energy outputs from unpredictable renewable sources, such as wind, vary with wind conditions and often produce large amounts of energy at off-peak times, such as a storm in the middle of the night. A wind/hydro-pumping combination could store the surplus energy to be released again during peak loads. Oddly enough, the opportunity for utility-scale storage will also become increasingly important with wide scale deployment of always-on capacity such as geothermal or nuclear. This way energy generated during off-peak hours can be temporarily stored until the next peak cycle.

A small but potentially significant initiative is the connection of small renewable generators to the grid. While each on their own is insignificant compared to a single large power source, the cumulative impact of a large number of micro generators could have a significant impact in the future. The benefit to the grid is two-fold. Firstly, micro generators reduce draw on the grid, effectively freeing up energy for others and deferring the need to build additional power plants. This can be especially effective for solar production whose high mid-day outputs are in sync with the high mid-day demands on the grid. Secondly, connected micro generators supply any surplus energy to the grid for use by other consumers, supplementing traditional power generators. Approximately one third of small wind generators are connected to the grid<sup>23</sup>.

Portability is another important consideration in determining the value of new fuel sources. With transportation responsible for 28% of all energy consumed by America, portable fuels for mobile applications are essential to the renewables energy portfolio. Liquid fuel in particular, as 96% of US transportation energy is consumed in liquid form as gasoline, diesel and jet fuel<sup>24</sup>.

Most renewables and alternative energy sources tend to be stationary. Wind, hydro and ocean installations are by nature stationary. Solar can be portable, but only at low energy levels. The use of fuel cells in vehicles involves the complication of transporting large amounts of hydrogen. Bio-fuels on the other hand are unique in that they are a storable, portable, liquid fuel source.

## Renewables Innovation

Deployment and innovation in renewable energy is proceeding at an unprecedented rate, fueled by rising energy costs and government subsidies. Advances in the underlying technologies along with improvements in manufacturing processes/yields and increases in manufacturing capacity are lowering the cost per kWh of renewables and increasing their competitiveness to fossil fuels. Developers of each technology are vying for market position, hoping to be part of a major breakout technology. Three renewables receiving much attention are bio-fuels, solar and wind.

**Bio-Fuels:** Brazil has a successful long been a leader in bio-fuels production. The economic success of Brazil's ethanol program is largely due to the abundant supply of sugarcane, its high yield and the high-energy ratio of 8-10 for the sugarcane-ethanol process. Energy ratio

represents the energy value of a fuel and is defined as the total energy available in the fuel relative to the total energy to grow, harvest and convert the biomass. The economics of the American ethanol industry are significantly weaker than Brazil, being predominantly based on corn with a smaller yield and an energy ratio of only 1.4-1.6.

#### Energy Ratios and Yields for Different Bio-Fuels Processes<sup>25</sup>

Ethanol Source	Energy Ratio	Yield (gallons/acre)	Energy Product (Energy ratio * yield)
Sugarcane	8-10	660	5280-6600
Cellulostic	4-5	1000-1500	4000-7500
Corn	1.4-1.6	330 <sup>26</sup>	462-528

The energy ratios and yields of cellulostic ethanol crops like switchgrass, prairie grass and miscanthus grass are each about three times that of corn. This results in an overall energy product about 10 times more than corn and in the same range as the economically successful Brazil cane ethanol. These crops are also easier to grow than corn, requiring little to no use of pesticides and irrigation. To help encourage growth of cellulostic ethanol, the US Department of Energy announced funding of \$33.8M for the development of commercially viable enzymes to hydrolyze and saccharify cellulostic biomass, an important step in converting the biomass into sugars<sup>27</sup>. DuPont has taken the bio-fuel cycle even further by bioengineering cellulose feedstocks for maximum energy ratios and developing a fermentation process to create bio-butanol rather than ethanol. Bio-butanol has a significant advantage that its fuel characteristics are more similar to gasoline than ethanol, making it compatible with gasoline-only vehicles and the existing gasoline distribution infrastructure<sup>28</sup>.

While programs to recycle waste vegetable oil into bio-diesel have been successful, the economics and sustainability of converting crops to bio-diesel has been widely debated. At the heart of the issue are yields, amount of available land and water required for irrigation. For instance, assuming all US farmland was used to grow soy for bio-diesel, the total production would only account for about 60% the gasoline and diesel consumed by the country in 2005<sup>29</sup>.

Recently Brasil Ecodiesel announced it had developed a breakthrough with a new high-yield castor oil process achieving an energy ratio of 10.5<sup>30</sup>, more than 3 times the typical USDA reference of 3.2 for bio-diesel<sup>31</sup>. Perhaps the most promising potential for bio-diesel is the use of algae as a feedstock. The rapid reproduction rate and high oil content of algae offers the potential of high yields within small land areas. Initial algae studies have resulted in yields 15 times greater than palm oil and more than 200 times greater than soy. It is no surprise that many companies are working to commercialize algae bioreactor systems.

#### Comparison of Indicative Oil Yields<sup>32</sup>

Crop	Oil (liters per hectare)
Soy	446
Safflower	779
Sunflower	952
Castor	1,413
Coconut	2,689
Palm	5,950
Algae	100,000

Source:

Second generation bio-fuel firms are harnessing synthetic biology and industrial biotechnology to create microbotic-based hydrocarbon fuels instead of alcohols. This approach removes the dependence on corn and seed oils, and gets around the food vs. fuel debate associated with first generation bio-fuels. As with DuPont's bio-butanol, these second generation bio-fuels have the advantage of being compatible with the existing petroleum distribution and consumption infrastructure.

**Solar:** High demand for solar solutions has accelerated developments in both silicon and non-silicon solar technologies. Silicon PV producers are working on new cell designs to increase module efficiencies and improvements in production and silicon utilization methods to help lower the costs of conventional solar systems. The use of nanotechnology is also being researched as a way to improve efficiency of conventional solar cells. Initial results indicate the potential of increasing output by 60% with the use of silicon nanoparticles, and even the ability to generate electricity from transparent glass windows<sup>33</sup>.

Meanwhile, interesting developments are taking place with thin film photovoltaic (TFPV) and organic PV technologies that could result in both usability and economic breakthroughs. Unlike conventional silicon cells, these solutions can be pliable, thin, transparent as film and even printed as solar inks. They also have the ability to operate under lower light conditions than silicon cells, changing the economics and expanding the range of potential installations/applications. Perhaps most important is the potential to produce solar capacity without the high capital expenditures and potential supply issues associated with silicon PV. The thin film photovoltaic (TFPV) market is forecast to reach \$7.2 billion by 2015 from just over \$1.0 billion today<sup>34</sup>.

Efficiencies of TFPV are predicted to reach 11-15% by 2015, with projected costs for rooftop models in the \$0.50-\$1.50/W, breaking the commercially important threshold of \$1 per watt. In comparison, silicon PV efficiencies for 2015 are forecasted at 18-22% with prices in the \$1.00-\$1.50 range<sup>9</sup>.

Just as subsidies are being used to promote solar deployment, they are also being used to encourage development. Starting in 2007, the Solar America Initiative will provide \$359 million over two years to promote the development of advanced solar technologies and make them cost competitive with other forms of electricity by 2015<sup>9</sup>. In Europe, the German government and a consortium of leading companies set up a joint fund of 360 million Euros to advance organic PC solar cell technology<sup>35</sup>.

**Wind:** Improvements in turbine and blade design are being made to increase efficiencies in areas with lower or changing wind profiles. The ability to operate in more diverse conditions expands the footprint of feasible wind farm locations by up to 20 times and allows sites to be much closer to load centers, reducing transmission distance by as much as 5 times<sup>36</sup>. Meanwhile the increased efficiency lowers the cost/kWh for wind energy in any condition. These innovations are applicable to both large and small wind projects.

## Dirty Energy Management

Complementing the clean energy efforts are initiatives to manage dirty energy sources. There are a number of programs in this area, including enhancing generator efficiency with capital upgrades to increase the energy/ton GHG ratio, pre-processing fuel for clean burning (such as coal gasification) and post-combustion scrubbing technology.

One post-combustion process that shows promise is CO<sub>2</sub> Sequestration in which CO<sub>2</sub> is captured and stored beneath the earth's crust as a way to prevent it from entering the

atmosphere. BP and Powerspan have recently announced an agreement to develop a CO<sub>2</sub> sequestration solution for use with traditional coal power plants. Pilot testing is scheduled for early 2008 at a FirstEnergy's facility to capture and store 20 tons CO<sub>2</sub> per day, roughly 2% of the plant's emissions<sup>37</sup>. Earlier this year, the US Department of Energy sponsored the development of the \$1.5 billion FutureGen coal-fired plant, designed to produce electricity and hydrogen while capturing and storing CO<sub>2</sub> in deep saline formations at depths of greater than 3000 feet<sup>38</sup>.

Of course, sometimes the most economical approach is to decommission the dirtiest and least productive plants. Many long-range plans call for the continued use of dirty plants until such a time that carbon economics makes them no longer feasible.

## Materials Sector Initiatives

Raw materials and chemicals are the basic building blocks of every tangible product. Even services, while not tangible in their own right, are underpinned by a series of products. As such, benefits from sustainability initiatives in this area extend beyond the materials sector and cascade throughout the product chain.

**Raw Materials and Chemicals:** Many raw materials and chemical manufacturing initiatives center on reducing their energy, water and toxic footprint. To develop cleaner and more efficient chemical processes, companies are changing selection of raw materials, seeking efficiencies to increase yield and reduce energy consumption, instituting programs to recycle chemicals and reuse by-products as well as looking at new technologies such as advanced membrane separation to physically rather than chemically separate mixtures. Initiatives also include innovation to replace chemicals identified as environmentally damaging with economically attractive alternatives. DuPont's program to phase out CFCs in light of the chemical's impact on the ozone layer resulted in a more environmentally friendly and economical HFC alternative<sup>39</sup>.

**Recycled Materials:** To reduce consumption of raw materials, efforts are being made to expand the extent and value of recycling programs. Innovation in recycling processes has resulted in a suite of basic and high-performance post-consumer materials. Programs to recycle materials for same use application have been successfully implemented for glass, metal and several plastics. An estimated 80% of recovered glass containers are made into new bottles, reducing the need for new raw materials<sup>40</sup>. Companies are also developing innovative processes to convert basic post-consumer material into higher value products, such as Patagonia's process of recycling plastic bottles to create its popular Synchronia fleece material.

**Next Generation Synthetics:** Historically, fabrics all came from natural materials. With the advent of polymers such as nylon, hydrocarbons were used to generate a new class of synthetics. Recent innovations bring the materials evolution full circle, creating synthetics based on bio-stocks instead of petroleum. This new class of materials delivers the benefits of synthetics without the heavy carbon footprint. DuPont's corn-based Sorona polymer is being marketed in applications ranging from high-end fabric to carpets<sup>41</sup>.

## Transportation Sector Initiatives

Transportation is a major source of global emissions and presents many excellent opportunities to reduce carbon impact. To put things in perspective, US transportation sector accounts for over a third of all transportation emissions worldwide and is approximately 10% of all energy related emissions worldwide. The problem is expanding with GHG from the US transportation sector forecasted to grow another 80% over the next 50 years<sup>42</sup>. Sustainability efforts in transportation include a number of initiatives encompassing both innovation and efficiency.

**Flex-Fuel Engines:** With slight modifications, traditional internal combustion engines can run on pure ethanol, gasoline or any ethanol-gas mix. The ability to burn pure or ethanol mixes reduces the net-new carbon impact on the environment and lowers the dependency on petroleum. Flex-fuel engines are well understood by the automotive industry and are popular in countries with wide-scale ethanol production. In Brazil, more than 80% of new car sales have flex-fuel engines<sup>43</sup> and Volkswagen, the first to offer flex-fuel cars in Brazil<sup>44</sup>, even planned to phase out gasoline-only cars in 2007<sup>45</sup>. In the US, flex-fuel vehicles are being marketed with no additional cost to the end user and service stations offering E85 are becoming increasingly popular in the Mid-West.

**Hybrids:** While flex-fuel vehicles reduce net-new carbon impact, hybrids combine a traditional engine with an electric motor to reduce absolute carbon impact and increase fuel efficiency. Hybrid technology lowers GHG emissions for both petroleum and bio-based fuels and can be used in conjunction with flex-fuel engines or vehicles burning bio-diesel. In the US, a hybrid vehicle typically costs anywhere from \$2000-\$3000 more, but this also includes a series of other unrelated features, making it hard to gauge the costs of the underlying technology. In return, hybrids offer fuel efficiencies (and associated carbon emission reductions) from anywhere from 25%-40% compared to similar gasoline-only vehicles<sup>46</sup>.

**Efficiencies:** Design improvements to large conventional engines have the potential to make significant impacts. GE's redesign of their locomotive engines resulted in emission reductions greater than 40% and with 3-5% reduction of fuel, without impacting horsepower<sup>47</sup>. In aviation, Pratt & Whitney's TALON combustor reduced NOx emissions by 30% on their popular PW4000 engine<sup>48</sup>.

**Transportation Method:** For most industries, transportation of goods and supplies is a basic requirement and while it cannot be avoided, it can be managed more effectively. Improvements in supply chain management systems provide enhanced visibility and permit the use of less expensive (and lower carbon footprint) forms of shipping. While determining the actual footprints for different transport methods are rather complicated, the footprint for air transport is many times that of sea, with reports as high as 100 times<sup>49</sup>. While total emissions from sea transport are higher than air, sea transport accounts for approximately 90% of all world trade<sup>50</sup>, resulting in a significantly lower emissions per ton shipped by sea.

**Product "Miles":** While many consumers simply look for the lowest price, the concept of the distance a product travels to get to market and the associated carbon footprint of transportation, is taking hold with a growing group of eco-conscious buyers. This is an especially popular environmental indicator in the food industry, where fresh produce is routinely transported by air. Concerns over transportation footprint have lead to a renewed interest in developing local markets with an emphasis on regional suppliers.

**Intelligent Fleet Management:** The use of fleet management to determine the most efficient routes can result in significant GHG reductions. These effects are compounded in high traffic areas where fleets are unproductively idling in traffic jams. Wireless fleet management services that monitor engine diagnostics can ensure fleets are running efficiency, obtaining the best mileage and creating lowest emission levels. Emission systems of modern engines are complex and require all systems to be properly functioning. A single defect in an emissions subsystem can in turn hurt the effectiveness of several subsystems, resulting in an increase of emissions as high as factor of 10 or more<sup>51</sup>.

## Retail Sector Initiatives

For many businesses, retail is the most important touch point to the consumer. Retail provides an opportunity to raise customer awareness of sustainability programs and to develop brand loyalty. It is also an opportunity for consumers to make their preferences heard, using purchasing power as the ultimate sign of approval. For many businesses, retail means a multitude of facilities to manage and the need to distribute at a regional, national or global level. Needless to say, there are many sustainability initiatives in this sector.

**Supply Chain Management:** Large retailers are increasingly pushing a green agenda down the supply-chain as a requirement of doing business. For instance Wal-Mart expects its eco-friendly packaging requirements will save the company in excess of \$3 billion, reduce emissions by 667,000 metric tons of CO<sub>2</sub> and prevent millions of pounds of trash from reaching landfills. The amount saved throughout the supply chain is three times that, forecasted at over \$10 billion<sup>52</sup>. This should be expected to grow as vendors seek to achieve economies of scale by standardizing on Wal-Mart's lean packaging specification for deliveries to their entire customer base.

**Product Innovation:** Retailers who also manufacture are increasingly appealing to the environmentally conscious consumer by creating green products. Individual efforts from these vanguard companies have often led to significant change throughout industry. Patagonia's development of Synchilla from recycled bottles spawned a new category of hugely successful fleece products across the industry. Similarly, Patagonia's leadership in developing the organic cotton market paved the way for Wal-Mart to eventually become the largest purchaser of organic cotton<sup>53</sup>.

**Customer Awareness:** In most sustainability initiatives, customer awareness programs are an important vehicle to build brand value. Earlier this year, Home Depot's Earth Day promotion gave away one million compact fluorescent light bulbs in an effort to create awareness of their "Eco Options" program, which includes 2,500 environmentally friendly products<sup>54</sup>. Similarly, Recreational Equipment Inc has created its "ecoSensitive" label to identify products with lower environmental impact. Their ecoSensitive label is being prominently displayed as part of their campaign to communicate that "as a socially responsible co-op, we care deeply about our impact on the planet"<sup>55</sup>.

**Facilities Management:** Power, water and materials management provide enormous savings opportunities when applied across a large retail footprint. This includes in-store efficiencies and more recently the trend use renewable energy. With more than 30,000 retail locations in 2006 and plans to grow to 40,000<sup>56</sup>, high on the Starbucks sustainability agenda was water conservation, waste and energy programs, including working with the US Green Building Council to develop LEED standards for its stores<sup>57</sup>. Some retailers, such as Coldwater Creek, purchase renewable energy from their utility, while others install renewable energy capacity onsite<sup>58</sup>. Walgreens has recently started a 20 store pilot program in which SunEdison installs and maintains solar panels on the roofs of its retail locations in return for a commitment to buy the electricity at an equivalent rate as the local utility<sup>59</sup>.

**Transportation:** When it comes time to find ways to meet the CEO's commitment to GHG reductions, transportation is usually targeted as an area for improvement. Please refer to the transportation sector initiatives for details on lowering costs and carbon footprints for distributing goods to retail locations.

## Information Technology Sector Initiatives

Like energy, IT has become pervasive across all sectors and while invisible in many ways, it forms a service backbone for almost all products. People rarely think about it, but computers and

communications are invoked for every cell phone call, every online purchase, every item shipped by a courier, every Google search and every invoice processed. In short, everything in the modern economy has an associated IT carbon footprint.

**Network and Server Infrastructure:** Until recently, computing and communications was all about capacity and speed, with little thought to energy requirements. Following Moore's Law, computing power and speed grew consistently to the point where, in some markets, it can cost more to power a server than to purchase it in the first place<sup>60</sup>. According to Sun Microsystems, the lack of power is limiting the ability of Lower Manhattan businesses to grow their datacenter operations<sup>61</sup>. In response, innovation has turned to designing low power chips that deliver high performance without the energy penalty. Network and server infrastructure manufacturers are focusing on reducing energy, space and cooling requirements with a new breed of high-density, high-capacity platforms using state of the art energy-efficient chipsets and components. The proposition is fundamentally ROI based and is especially attractive to businesses that have hit power, size or cooling barriers in their existing installations.

**Virtualization:** When analyzing efficiency improvements, one option is to eliminate a facility altogether. Virtualization favors consolidating many distributed datacenters into a specially designed, centralized "über" facility. Google's advanced data center facility, affectionately known as a Googleplex, is reputed as being by far the most efficient and economical datacenter. While some argue the Googleplex is search specific, the concept of achieving Google economies of scale for applications across the board holds merit.

**Recycling e-Waste:** Equipment vendors are increasing e-waste collection and recycling in efforts to reduce heavy metal and toxins levels in local landfills. Companies such as Dell and HP have long standing e-cycling programs as part of their cradle-to-grave sustainability programs. HP reports it has recycled 1 billion pounds of electronics and print cartridges<sup>62</sup>, while Dell reports and 93% increase in e-cycling over last year<sup>63</sup>.

## ***Carbon Mitigation***

Carbon mitigation is a way for businesses to meet legal requirements through cap-and-trade programs where offsets are bought and sold within a formal trading framework. Mitigation is also increasingly popular with companies or individuals who wish to be carbon-neutral in part or all of their activities. These carbon offsets are marketed by both for-profit and NGOs.

**Carbon Trading:** The two principal forms of carbon trading are mandatory and voluntary. The Kyoto Protocol set forth mandatory reduction targets for members with industrialized or transitional economies. Under the Kyoto Protocol, the European Trading Scheme is the largest and most popular mandatory cap-and-trade program. The first phase of the program is while limited to the EU's largest CO<sub>2</sub> emitters in the power and heat generation industry and in selected energy-intensive sectors. None the less, it covers 11,500 companies and utilities in 25 countries, and accounts for approximately 45% of the EU's total CO<sub>2</sub> emissions<sup>64</sup>. With the US deciding to remain outside of the Kyoto convention, London quickly became the center for carbon trading with the European Climate Exchange (ECX).

While exempt from federal mandatory emission restrictions in the US, demand for a solution has resulted the creation of State led initiatives for mandatory caps on utilities. On the east coast, the Regional Greenhouse Gas Initiative (RGGI) was formed to impose mandatory GHG limits on the energy market in its nine member States through a cap and trade program<sup>65</sup>. The Western Climate Initiative has a similar program for its six State and two Provincial members<sup>66</sup>.

Lack of mandatory emissions industry-wide in the US also led to the development of a voluntary carbon trading market. Companies participating in the Chicago Climate Exchange (CCX) make

legally binding commitments to reductions and trade allowances as appropriate. Members include many progressive companies across all major sectors such as transportation, chemicals, mining and forest, power utilities, electronics, manufacturing, and technology.

A less restrictive offset market without legally binding commitments is also available. Companies and increasingly individuals who wish to reduce their carbon footprint or become carbon neutral can purchase RECs from a number of for profit and NGOs. Carbon offsets are one of the tools being used by Google and Yahoo to meet their goals of becoming carbon neutral by the end of 2007.

**Popular Offsets:** Trees are the most popular offset offered, including reforestation (planting where trees were cut), afforestation (planting in non-forest areas) and protection of forest habitat. Offsets also include Renewable Energy Credits (RECs) for alternate renewable forms of energy (wind, solar, methane projects), energy conservation and fuel switching.

**Offset Accounting:** The value of a carbon offset and its legitimacy as a tradable instrument are measured through the process of offset accounting. Offset accounting focuses on Additionally (the incremental contribution of the specific program), Redundancy (what plans are already in place that may have had the same effect), Leakage (what emissions are created in executing the offset) and Permanence (how long term is the effect).

## ***Tomorrow's Sustainability***

The rapid rise of sustainability initiatives in corporate America and globally are a reflection that a critical mass has indeed heard the wake up call on climate change and has started to change its thought process to include sustainability in business and consumer decisions. For many businesses, efficiency improvements are the "low hanging fruit of sustainability" and are a good place to get started. As companies gain experience and success, sustainability will extend deeper and be incorporated earlier into new product cycles, resulting in increased financial and environmental benefits. The sustainability market is still young. The opportunity to capture brand loyalty of the increasingly environmentally aware consumer base is wide open and will result in big winners and loser in the coming years.

Today's sustainability efforts create a series of wedges that can collectively alter the rate of climate change. This meets the initial objective of taking us off a fast track of environmental decay and is an essential step in real change. In doing so, we plant the seeds for the macro-innovation and changes in human behavior required for long term sustainability. Long-term sustainability requires far more than efficiencies and innovation in a carbon economy. It requires major breakthroughs to take us to a non-carbon economy. An economy that will look to carbon not as an energy source but as a building block of life.

It won't be easy. The carbon economy has incredible inertia. The political and financial power structures of the world were forged on and are fed by hydrocarbons. The change to a non-carbon economy threatens to unbalance this status quo, possibly in very dramatic ways. Once again, there will be big winners and losers, but this time on an exponential scale. Regardless of its inertia, advances and breakthroughs will invariably occur amidst this backdrop, prompting the human drama that will play out as we move to a non-carbon economy. In the meantime, we have our work cut out for us building wedges.

## ***About the Author***

A business strategist and technologist, John Lash heard the call for climate change. With over 20 years experience in high tech and telecommunication, Lash now promotes sustainability as an

opportunity for businesses to drive bottom line and increase brand value by being environmentally responsible.

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- <sup>1</sup> US Department of Energy, Energy Information Industry, *Annual Energy Review 2006*, June 27, 2007
  - <sup>2</sup> Hydro Research Foundation, *Hydropower Today*, August 2007
  - <sup>3</sup> RenewableEnergyAccess.com, *EU to Fall Just Short of 2010 Renewable Target*, August 31, 2007
  - <sup>4</sup> RenewableEnergyAccess.com, *Renewables Making Gains in Congress, January 19, 2007*
  - <sup>5</sup> ConEdison, *ConEdison Solutions' GREEN Power*, August 2007
  - <sup>6</sup> GreenBiz.com, *Google to House Largest U.S. Corporate Solar Installation*, October 17, 2006
  - <sup>7</sup> American Council on Renewable Energy, *The Outlook on Renewable Energy in America, Volume II: Joint Summary Report*, March 2007
  - <sup>8</sup> Global Wind Energy Council, *Global Wind 2006 Report*, May 11, 2007
  - <sup>9</sup> US Department of Energy, DOE Solar Energy Technologies Program, *DOE Solar Energy Program Overview Market Trends, Strategy, R&D Pipeline, Next Steps*, August 2007
  - <sup>10</sup> US Department of State, *Bush Urges Cuts in Gasoline Use, More Biofuel Production*, January 24, 2007
  - <sup>11</sup> Green Car Congress, *EU Leaders Agree on Renewables, Biofuel Mandates and Greenhouse Gas Reductions*, March 9, 2007
  - <sup>12</sup> Emerging Markets Online, *Biodiesel 2020: The Emerging Markets*, October 2006
  - <sup>13</sup> Helmut Kaiser Consultancy, *Biogas Plant Markets Boom Worldwide in Municipalities, Industry and Agriculture*, July 12 2007
  - <sup>14</sup> US Department of Energy, Office of Energy Efficiency and Renewable Energy, National Renewable Energy Laboratory, *Geothermal – The Energy Under Our Feet, Geothermal Resource Estimates for the United States*, November 2006
  - <sup>15</sup> US Department of Energy, *Hydrogen, Fuel Cells & Infrastructure Technologies Program*, August 2007
  - <sup>16</sup> US Fuel Cell Council, *Fuel Cell Industry Highlights Available Products*, November 13, 2006
  - <sup>17</sup> Ontario Hydro, *Monthly Market Update*, July 2007
  - <sup>18</sup> Engineering Institute of Canada, *Climate Change Conference*, 2006
  - <sup>19</sup> US Department of Energy, *Renewable Energy Overview 2005*, August 14, 2007
  - <sup>20</sup> Energy Efficiency and Renewable Energy, *Annual Report on US Wind Power Installation, Cost, and Performance Trends: 2006*, May 2007
  - <sup>21</sup> SolarBuzz, *Industrial Price Index*, September 2007
  - <sup>22</sup> US Department of Energy, *EERE.com Geothermal FAQs*, September 2007
  - <sup>23</sup> American Wind Energy Association, *AWAE Small Wind Turbine Global Market Study*, 2007
  - <sup>24</sup> US Department of Energy, *Transportation Energy Data Book: Edition 24-2004*
  - <sup>25</sup> CLEAN Energy, *Cellulosic Ethanol: A Greener Alternative*, June 2006
  - <sup>26</sup> International Energy Report, *Biofuels for Transport*, 2004
  - <sup>27</sup> RenewableEnergyAccess.com, *Department of Energy Offers \$33.8 Million for Cellulosic Biofuels Projects*, August 28, 2007
  - <sup>28</sup> DuPont, *2015 Sustainability Goals, Solutions for a Better, Safer, Healthier World*, 2006
  - <sup>29</sup> Based on 938,279,000 acres of US farm land [Farmlandinfo.com], yield of 446 liters/acre [Oilgae.com], 98% conversion rate from oil to bio-diesel [Pioneer.com] and consumption rates of 139.9 billion gallons of gasoline and 38 billion gallons diesel consumed by US in transportation for 2005 [United States Department of Agriculture, Foreign Agriculture Service, July 2006]
  - <sup>30</sup> Bnamericas.com, *Brasil Ecodiesel Announces Development of High Yield Biodiesel*, May 1, 2007
  - <sup>31</sup> RenewableEnergyAccess.com, *What is Biodiesel's Energy Balance?*, July 12, 2005
  - <sup>32</sup> Oilgae.com, *Comparison of Average Oil Yields from Algae with that from Other Oilseeds*, August 2007
  - <sup>33</sup> Octillion Corp., *Solar Cell Power Performance Boosted 60-70% by Nanoparticles Used in Octillions "NanoPower Window"*, August 20, 2007
  - <sup>34</sup> NanoMarkets, *Thin-Film, Organic and Printable Photovoltaics Markets 2007-2015*, August 6, 2007
  - <sup>35</sup> German Federal Ministry of Education and Research, *Organic Photovoltaics – Plastics for Energy From Light*, August 2007
  - <sup>36</sup> US Department of Energy, Office of Energy Efficiency and Renewable Energy, *Wind Energy Program 2007-2012*
  - <sup>37</sup> BP Alternative Energy, *BP and Powerspan Collaborate*, August 8, 2007

- 
- <sup>38</sup> US Department of Energy, *FutureGen – Tomorrows Pollution-Free Power Plant* web site
- <sup>39</sup> DuPont, *History Of DuPont Refrigerants 1980-1990*, September 2007
- <sup>40</sup> Glass Packaging Institute, *Glass Recycling and the Environment*, August 2007
- <sup>41</sup> DuPont, *Welcome to DuPont Sorona Polymer*, August 2007
- <sup>42</sup> US Environmental Protection Agency, *A Wedge Analysis of the U.S. Transportation Sector*, April 2007
- <sup>43</sup> Newsweek, *The Future of Flex-Fuel Lies in Brazil*, July 2007
- <sup>44</sup> The Wall Street Journal, *As Brazil Fills Up on Ethanol, It Weans Off Energy Imports*, January 16, 2006
- <sup>45</sup> Reuters, *Volkswagen to Stop Making Gas-Only Cars for Brazil*, March 23, 2006
- <sup>46</sup> CNN Money.com, *Hybrid vs. Diesel vs. Flex-Fuel*, August 2007
- <sup>47</sup> General Electric, *Eco-imagination Kazakhstan Evolution Locomotive*, 2007
- <sup>48</sup> Pratt & Whitney, *Environment, Health & Safety, Leading the Way to a Cleaner, Healthier Environment*, September, 2007
- <sup>49</sup> Treehugger, *Shipping vs. Airfreight Revisited: Some More Considerations*, March 11, 2007
- <sup>50</sup> The Guardian, *CO2 Output from Shipping Twice as Much as Airlines*, March 3, 2007
- <sup>51</sup> Chevron, *Gasoline and Air Quality, Vehicle Emissions: Limits*, August 2007
- <sup>52</sup> BBC News, *Wal-Mart Goes Green on Packaging*, September 22, 2006
- <sup>53</sup> Fortune Magazine, *Patagonia: Blueprint for Green Business*, April 5, 2007
- <sup>54</sup> Home Depot, *Home Depot Introduces Eco Options*, April 17, 2007
- <sup>55</sup> Greenbiz, *REI Launches Eco-Sensitive Product Line*, August 21, 2007
- <sup>56</sup> MSNBC, *Starbucks to Double North American Stores*, October 5, 2006
- <sup>57</sup> Starbucks, *Understanding and Improving our Environmental Footprint*, September 2007
- <sup>58</sup> Coldwater Creek, *Coldwater Creek Makes Companywide Conversion to Renewable "Green" Energy*, August 23, 2006
- <sup>59</sup> National Public Radio, *Big Retail Stores Prime Solar Energy Generators*, June 28, 2007
- <sup>60</sup> Sun Microsystems, *Datacenter Reference Guide – White Paper*, July 2007
- <sup>61</sup> Sun Microsystems, *SunEco Podcast with Dave Douglas, VP Eco*, August 2007
- <sup>62</sup> GreenerComputing, *HP Hits 1 Billion Pound Recycling Mark*, July 16, 2007
- <sup>63</sup> GreenerComputing, *Dell Boosts its Electronic Recycling by 93 Percent*, July 20, 2007
- <sup>64</sup> European Commission, *EU Action Against Climate Change, EU Emissions Trading*, September 2005
- <sup>65</sup> Regional Greenhouse Gas Initiative (rggi.com), *About RGGI*, August 2007
- <sup>66</sup> US Department of Energy, ERRE Information Center, *Six Western States and Two Provinces Set Greenhouse Gas Goals*, August 29, 2007