Investment, CleanTech

CleanTech *refers to technologies and business models that improve a product or a service's performance, productivity, or efficiency while reducing costs, using less energy and fewer materials, and lessening environmental damage. CleanTech investment in diverse sectors, including energy, water and wastewater treatment, manufacturing, advanced materials, transportation, and agriculture, provides competitive returns for investors and customers. Standardization, legislation, long-term planning, and incentives mediate its risks.*

Since 2004, investment in the venture capital category known as CleanTech has emerged as a new trend that is fundamentally changing the face of the business of sustainability. Such technology—solar power, fuel cells, and aquaculture, for example—drives innovation as it has the potential to become an integral part of corporate value chains. (A "value chain" is a series of activities whose goal is to create value that exceeds the cost of providing a product or service, thereby generating a profit margin.) CleanTech refers to the "clean" technologies and business models that address the source of ecological problems caused by a product or a service's manufacturing or development process. It improves the product or service's performance, its productivity, or its efficiency as it reduces costs, uses less energy and fewer materials, and causes less environmental damage. Such technologies are clustered in diverse industry sectors, including energy (about two-thirds of total investment), water and wastewater treatment, manufacturing, advanced materials, transportation, and agriculture. The products or services cover a wide range including: energy-efficient lighting; wind and solar energy; water filtration; next-generation batteries; advanced materials that make products lighter, stronger, and/or cheaper; nontoxic pesticides; and enabling technologies that improve the performance of smart electricity grids.

Companies are realizing that integrating CleanTech solutions into their operations can potentially "green" their supply chains. It will also reduce their exposure to the uncertainties of climate change and water shortages and pollution, increase market valuations (the amount consumers are willing to pay), and, particularly, develop additional income streams in new markets. The challenge for corporations is to weigh the investment in CleanTech solutions, which often are capital intensive, against the solutions' potential long-term business value. For example, corporations and investors need to contend with the uncertainty of a technology's scalability or robustness and the need for new business models that would allow them to capture the value of the investment. They also need to consider the uncertainties of the financial markets that have hindered debt financing and public offerings, the volatility of oil prices, and the range of proposed policies aimed at adapting to climate change and reducing carbon emissions.

The CleanTech investment space is characterized by high capital investment, long technology-development cycles, a high degree of dependence on government policy, and (as of this early stage) uncertain exit strategies for investors. These characteristics contrast with typical information technology elements (e.g., materials in the solar value chain and smart grids that deliver electricity from alternative power sources), biotechnology (e.g., algae biofuels), and several other more mature investment domains. Hence new business models are needed for CleanTech investments, because investors and businesses that have transitioned from information technology or biotechnology into CleanTech have experienced a significant learning curve, particularly as it pertains to the valuation of companies, the size of investment rounds, and the potential

for exit strategies (acquisitions or initial public offerings). The 2009 initial public offering of A123 Systems, which makes lithium-ion batteries that could be used in smart grids, potentially opened a window to access public markets profitably. Acquisitions, however, remain the most likely exit strategy.

Evidence is emerging that corporations are increasingly investing in CleanTech start-ups, joint ventures, and outright acquisitions, particularly in the energy, biofuel, and water-treatment technology areas, for the purpose of strategic differentiation and revenue growth. Examples include Exxon's $600 million investment in Synthetic Genomics during 2009 to develop superior algae strains for biodiesel production, General Electric's 2009 investment in A123 Systems, and Walmart's investment in energy- and water-efficiency companies to reduce carbon and water footprints (Cleantech Group 2009). (Carbon footprints and water footprints measure the amount of greenhouse gases created in the production of goods and services or the amount of freshwater used during daily activities, respectively.) The market for these technologies continues to expand, as more investors and corporations realize how sustainability-driven innovation through investment in CleanTech can better use natural resources in a way that provides economic value. What has fueled this trend, why are companies investing in CleanTech, and how is it related to leading innovations for corporate environmental sustainability?

Growth and Expansion

In the United States, CleanTech dates to the 1970s, when the environmental movement came of age after the Environmental Protection Agency was established. At that time, Congress enacted legislation such as the Clean Air Act and the Clean Water Act in response to public sentiment against environmental pollution and to the widespread evidence of environmental and public health hazards. These events and the oil crisis of 1973 prompted research and technology development for alternative energy generation, water-treatment processes, and "end-of-pipe" environmental treatment technologies that deal with pollution after it happens. Many of these technologies, however, were in an early stage of development, were too expensive, and did not have widespread political support; very few established companies embraced the innovative potential of this sector. This was due, in part, to the cost of these solutions and the absence of business models that would allow investors and companies to capture attractive returns. As a result, environmental technologies were often only implemented in small markets driven by regulatory compliance. Because of these events, the Cleantech Group (which coined and trademarked the term *cleantech*) argues that CleanTech should not be confused with the terms *environmental technology* or *green tech*, commonly used in the 1970s and 1980s.

To date, scores of companies and organizations in the United States and Europe are driving CleanTech business development and helping investors and corporations identify investment and acquisition opportunities. These include Clean Edge, a research and publishing firm dedicated to the CleanTech sector, which targets investors and entrepreneurs; Lux Research, an independent research and advisory firm, which provides corporations and investment funds with strategic advice and ongoing intelligence for emerging technologies; and Cleantech Europe, an advisory firm for entrepreneurs and investors, which canvasses the entire CleanTech space. Aside from business intelligence firms, the financial services industry has embraced CleanTech and focuses on the energy sector by establishing either new specializations within a firm or independent boutique operations.

Even at the start of the twenty-first century, the term *CleanTech* was not in the financial or business community's vocabulary. But since 2004, the sector has matured and gained recognition because it couples new CleanTech products or services with new business models that offer competitive returns for investors and customers. In recent years, this sector has seen a surge in financial innovations that drive businesses and consumers to adopt clean technologies. For example, rooftop solar technology is driven by long-term leasing and purchasing programs. In these programs, the technology is owned and maintained by the solar company, which also negotiates electricity rates with the utility to enable rebates to the consumer. These low-risk value propositions to consumers and peak power–demand mitigation values to utilities are becoming the mainstream for residential and commercial energy production and are being adopted in the waste-to-energy sector. A number of strategic drivers, which determine the success or direction of a company's business strategy, have spurred CleanTech's rapid growth. These drivers include the availability of private and public capital; the decreasing cost of technologies, which affects the scalability of solutions; the competition between governments to build jobs for the green economy; the certainty of climate change, which is influencing companies to disclose and mitigate their exposure risks; a changing consumer base that demands sustainable goods and services; and the resource demands of emerging economies such as India's and China's.

The best evidence that CleanTech has entered the mainstream is that governments around the world have made greening of the economy the centerpiece of their stimulus programs, at a cost that some estimate to be over $500 billion (Edenhofer and Stern 2009). This injection of government capital has accelerated investors' and corporations' interest, resulting in a green technology market rebound of

36 percent in the second quarter of 2009. At that time, more than three thousand venture-backed CleanTech companies were operating globally. Many more were funded through corporate investment, debt-equity financing, wealthy individuals, and government grants. Thus the intent of the technology, and the CleanTech venture based on it, is to mitigate carbon or water footprints through efficiency gains or other means because of their business value. Yet unintended consequences can result when forces other than markets pick which measures will be successes or failures. This has been the case with the ethanol biofuel mandates in the United States and the subsidies and preferential feed-in tariffs for solar and wind energy in Europe. Farmland gave way to energy farms, and food commodity prices spiked as a result. Hence the integration of policies and CleanTech solutions is awkward. Indeed, given the uncertainty of the outcome of the U.N.'s 2009 Copenhagen climate discussions (COP-15), venture firms and entrepreneurs have been positioning themselves to become increasingly less reliant on environmental policies that may have unintended consequences or determine business value.

Impact on Sustainability

Corporations that make targeted investments in internal research and development, joint ventures, and acquisitions of companies that use disruptive technology (advances that improve a product or service in ways that are unexpected by the market) are creating both effective, innovative CleanTech solutions and value in their operations. This is where innovation in clean technologies and sustainability objectives intersect. The rationale is that technology investments help resolve the potential impacts of climate change and water risks on the long-term growth strategies (and thus market valuations) of corporations. Since 2004, disclosures in the financial market of economic, environmental, and social performance have become increasingly common in financial reporting and are important to organizational success. This is evident from corporations' disclosures in their Securities and Exchange Commission (SEC) filings of climate risks to their operations and supply chains and from their innovative solutions to reduce their exposure to the risk.

The Dow Jones Sustainability Indexes (DJSI) have tracked the financial performance of the leading sustainability-driven companies worldwide since 2000, and many organizations such as Ceres, the RiskMetrics Group, and the Carbon Disclosure Project analyze sustainability indicators. For example, Ceres is a national coalition of investors, environmental groups, and other public interest organizations that work with companies to address sustainability challenges such as global climate change. Ceres directs the Investor Network on Climate Risk, a group of more than seventy institutional investors from the United States and Europe that manage over $7 trillion in assets. A 2008 report published by Ceres describes how sixty-three of the largest consumer and technology companies across all industry sectors are positioning themselves to respond to the effects of climate change on their massive operations and supply chains (Risk Metrics 2008, 3). In the responses, the companies plan to reduce their carbon and water footprints. But because sustainability will increasingly become a driver for corporate strategy and differentiation, companies will need next-generation practices that change the existing business paradigms. To develop innovations that lead to next practices, executives must question the implicit assumptions behind their current practices. The Ceres report's recommended actions involve changing pay reward structures, governance systems, and supply chain management; setting renewable energy purchasing targets; and strategically investing in disruptive technologies. CleanTech allows businesses to change the way they operate, because technology differentiation results in strategic differentiation from the competition within and outside their industry sectors.

Many companies focus on the large portion of their carbon and water footprints that are in their supply chains. A number of leading companies began by managing their risks and developing standards to measure their emissions, and then moved forward to identify easy-to-achieve changes and the type of CleanTech investments to target. Consider Nike, whose extensive chain of footwear manufacturing sites accounts for 60 percent of its total carbon footprint. Because it is difficult to measure and control greenhouse gas emissions from raw materials processing, component suppliers, and the transportation of goods, these sites must collaborate with one another and with suppliers. Around 2009, Coca-Cola and Molson Coors started implementing a common industry standard to measure product lifecycle emissions, concentrating on managing their water footprints across the entire supply chain. Dell, Walmart, and several other companies directly engage suppliers in China to ensure that greenhouse gas emissions are assessed and reported.

But many companies go further. Walmart invested in CleanTech companies and technologies that offer solutions for greening their operations. For example, it implemented energy-efficient heating and lighting systems and pervious roofs and parking lot surfaces to restore the hydraulic cycle that moves water through land, the oceans, and the atmosphere. Walmart is even exploring colocating its warehouses with landfill gasification projects to form an off-grid power source. Energy companies such as Exxon and Chevron (alongside venture capital firms) invested heavily in algae biofuel start-up companies because they recognize that algae biodiesel technology may be scalable and produce an alternative to oil. Thus, they explored greening their product mix and tapped into new markets. These companies are particularly focused on the early stages in the value chain, such as the isolation, selection, and genetic engineering of highly efficient strains of algae, and the related extraction process technology. Engineering manufacturing companies such as Bosch and Siemens are diversifying in green technology by investing in start-ups across the solar and wind value chain and through acquisitions. Proponents of improving the corporate value chain believe that core engineering know-how can be directed to improve alternative energy and other technologies. This allows companies to tap into new markets while integrating the innovations into their operations and supply chains.

Risks and Controversies

The investment decisions in the growth and opportunities of CleanTech companies are at the center of a perfect storm: governments are unlocking unprecedented amounts of stimulus funds in order to green economies. Some argue that companies on the DJSI, compared with those not on the list, exhibit an increase of up to 15 percent in price-earnings ratios, indicating that the market values these companies more than it values companies that do not meet sustainability metrics. The market is looking at companies' climate risk disclosures in SEC filings. In addition, climate policies are influencing industry value chains, carbon markets for emissions trading, and consumer behaviors. Yet risks, unintended consequences, and other controversies may affect the future development of CleanTech innovations. Among these impacts are "greenwashing," or incorrectly stating the environmental benefits of a product, technology, or practice; the risk of governments awarding funds and determining policies based on a company's massive investment in targeted innovations; the risk of companies failing to make long-term plans; and the green paradox that policies aimed at curbing emissions may result in the acceleration of oil production.

How can companies and governments address these issues? First, some reporting standards for greening the supply chain and operations are emerging, and analysts are using them. As of the beginning of the twenty-first century, the implementation of climate and water risk reporting within companies is voluntary, and the metrics for various products and services are arbitrary. Increasing the standards of reporting and continuing to release disclosures will aid in the elimination of these risks. If the reporting of climate risks and the proposed mitigation strategies for companies, regardless of sectors, can be standardized, then corporations can hedge their financial risks to climate change and water risk uncertainties. For example, Swiss Re (a leading global reinsurer) and others are piloting weather insurance products that would reduce crop price volatility (affecting the food, beverage, and clothing industries) and transfer risk to financial players (the reinsurers or investors).

Second, the infusion of government capital will have the potential to remake alternative energy and other green technology businesses, influence investment returns, and affect industry value chains. For example, the United States's 2009 "green" economic stimulus plan targets a clean energy future by allotting $117.2 billion, or 12 percent of the $787.2 billion plan (Edenhofer and Stern 2009). It will achieve this through the development of plug-in hybrid cars and renewable energy technology, investment in energy efficiency, and a cap-and-trade program for trading pollution credits in order to reduce greenhouse gas emissions. China's government committed to a circular economy concept that would reduce, reuse, and recycle resources during manufacturing, transportation, and consumption by allotting $218 billion, or 33.4 percent of its budget. This legislation will allow Chinese auto manufacturers to leapfrog automotive technology by a generation and lead the green car revolution. It also identifies an official target for the capacity of installed solar and wind energy plants that well exceeds that of the United States. But history has shown that letting governments rather than markets decide what measures will be successful may be risky. For example, the U.S. government credits for biofuel growers have pushed up commodity prices and caused a food-for-oil trade-off, affecting poor populations and increasing the water footprints of the biofuel industry. The emphasis on hybrid electric or all-electric cars, with their dependence on scarce supplies of lithium-ion batteries, leaves companies exposed to political risk and unsustainable extraction practices.

Third, companies must have a long-term plan that considers the opportunities and sustainability of their investments in CleanTech. The view that CleanTech is a mere add-on with a good cost-benefit ratio is shortsighted. These myopic views may result in companies shedding CleanTech when the market or policy incentives change, meaning the technology's social and environmental impacts will be small. The integration of CleanTech into the company's

value structure has a greater potential to shift the company's competitive strategy and have a lasting impact for sustainability.

Finally, the so-called green paradox argues that as governments and companies strive to reduce emissions by reducing fossil fuel consumption (through CleanTech innovations in alternative energy, improved building insulation, and efficient cars), the global extraction of coal, gas, and oil will increase. The argument is that as companies green the economy, they exert a downward pressure on future fossil fuel prices (because less is needed). To maintain profits, owners of oil and gas fields will increase production, thus exacerbating climate change. The implication is that policies need to offer incentives for owners to leave supplies in the ground, rather than attempt to curb demand. The paradox is that curbs on demand have stimulated considerable CleanTech innovation. Taxation disincentives for owners are not politically viable, so a global carbon emissions trading system may be able to cap fuel consumption and slow down extraction rates. This would spur further innovations in carbon financing and bring financial and insurance services up the green value chain. (Carbon financing, as part of the Kyoto Protocol, generally refers to investments in greenhouse gas emission reduction projects and the creation of financial instruments that are tradable on the carbon market. The value chain essentially consists of three major players: project owners, traders or brokers, and buyers of carbon offsets. Even though not all greenhouse gas mitigation projects carry the same value, the carbon markets and their financial services players attempt to authenticate and verify the value of the offsets through financial instruments.)

Future Outlook

The fact that viable business models are generating attractive returns to investors and corporations shows that CleanTech is here to stay, regardless of the market, policy, and technology challenges it poses to corporate operations and value chains. While the United States's 2009 economic stimulus funding will be expended over two years, the impact in the markets of its green investment will take much longer to appear. The traction of SEC filings will continue as more companies participate in the disclosure of climate risks or participate in the Carbon Disclosure Project. With the standardization of measurements coming of age, companies will more easily measure their carbon and water footprints and identify opportunities to mitigate risks. Project financing and insurance pricing are increasingly tied to the climate exposures of corporations, and hence future favorable rates may induce companies to adopt carbon and water management strategies and consider integrating CleanTech solutions into their competitive strategies. In light of the maturation of the sector since 2004, which was driven by venture capital and private equity, the early twenty-first century will be driven by growth and expansion in the mainstream economy that is fueled by government programs. It is, however, important to differentiate the outlook by technology domain.

Energy will continue to be the main sector for investment, particularly transportation (batteries and fuel cells), biofuels (algae and noncrop plants), and the continued expansion of solar and wind power. In the third quarter of 2009, CleanTech investments for the first time exceeded those in software, biomedical devices, and biotechnology, with 25 percent of the total venture investment occurring in the United States (Cleantech Group 2009, 13). Solar is the top sector, with a 28 percent share of investment, closely followed by transportation (25 percent) and biofuels (9 percent) (Cleantech Group 2009, 10). In the short term, analysts expect major consolidation to occur in the value chains for these industries. The causes are the role of government, private capital shortages, overcapacity in the face of lower energy demand, and decreasing prices for the integrated technology. This consolidation will stimulate investment in energy companies because investors can control the whole supply chain and respond to U.S. mandates under the stimulus package. This trend is already evident for the solar industry and is likely to follow in the wind industry. New financial models and incentives will be needed to ensure the stability of this CleanTech industry. For example, utilities pay feed-in tariffs, or set prices for paying the end users who provide solar power to the power grid. Making these tariffs consistent across all solar projects (as is proposed in China) will reduce costs and make the projects viable, thereby allowing companies to calculate risks and returns. Even though it is hard to project where investments are headed, findings from Deloitte Touche Tohmatsu's 2009 *Global Trends in Venture Capital* report shows that 63 percent of venture capitalists around the globe intend to increase their exposure to the CleanTech category over the next three years—a far higher percentage than any other sector. The trend looks set to continue for some time.

The demand for renewable energy by utilities is growing, as they must comply with state (and most likely federal) renewable portfolio standards (RPSs) by 2020. The doubts some have that the widespread, integral use of solar power in the RPSs are waning. (Even in the oil- and gas-intensive city of Houston, Texas, utilities are buying solar technology.) Global competition is playing a role as well, with capacity targets for installed alternative energy systems in China rapidly eclipsing those in the United States. A major challenge, aside from policy incentives, is the creation of a smart grid that can handle the highly variable production of electricity from renewable energy sources, one that will

allow for storage and can track the "green" and "brown" electrons. A smart grid links power production, transmission, and distribution from centralized (e.g., coal-fired power plants) and distributed sources (e.g., wind farms or electric vehicles) with consumer demand. With electricity being generated from traditional coal or oil plants (brown electrons) as well as from the wind, solar energy, biofuels, and batteries (green electrons), an intricate management system needs to be developed. In the United States, many start-up companies in all parts of the value chain are working together to develop enabling technologies and management aspects that meet a federal mandate to create a smart grid. Considering the fixed infrastructure of the current grid, companies will likely locate green smart grids along corridors (e.g., in Arizona and California) to test their feasibility. Bond measures will likely fund their construction in a piecemeal fashion, and business models will be developed to monetize them with attractive returns.

In other sectors, advances in battery technology aside from lithium-ion batteries will fuel the generation of cars that will be developed in the second decade of the century. But first, battery costs must come down and their efficiency must improve. Experience with hybrid technology and General Motors's Volt electric car will prove invaluable to assess market demand for this technology and to drive innovations in electrical grid infrastructure. Experience with hybrid and electric technology might also affect business models pertaining to the purchase, maintenance, and afterlife care of the battery system. Corporations may be highly motivated to move in this direction because of their investments in fuel-efficient fleets, whether on an ownership, lease, or joint venture basis. Future fuel prices, the cost of technology, and government incentives will play a major role in the adoption of this technology. Considering the long development cycles and fragmentation of the industry, these innovations will presumably have a long time on the horizon before they play out in the marketplace.

Finally, conservative deregulation in the water industry sector has seen much innovation and investment or acquisition activity, both for ultrahigh-purity and high-volume applications. For example, General Electric acquired Canada's Glegg Water Company, which developed a superior electrodeionization technology and product (the E-Cell) for ultraclean water treatment. Targeting high-value customers such as the pharmaceutical and semiconductor industries, General Electric's Water and Process Technologies division recognized the opportunity as an acquisition and business opportunity. Two main strategic drivers will increase investments in water technologies: SEC disclosures of corporate water footprints and the energy–water nexus. This nexus includes CleanTech innovations that address the energy used for water conveyance and treatment (e.g., to operate filtration systems, microturbines, and fuel cells). Other innovations address water use for energy production from coal, gas, nuclear, biofuel, and utility-scale solar sources. This water industry sector is moving up the value chain due to a number of factors. First, climate change affects corporate risks to water availability and quality. Second, water costs for corporate users are being renegotiated, and finally, multistakeholder water use is starting to drive new legislation.

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See also Biomimicry; Cap-and-Trade Legislation; Climate Change Disclosure; Energy Efficiency; Energy Industries—Overview of Renewables; Green-Collar Jobs; Investment, Socially Responsible (SRI); Product-Service Systems (PSSs); Risk Management; Supply Chain Management; True Cost Economics

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