CLEANTECH VENTURE CAPITAL: HOW PUBLIC POLICY HAS STIMULATED PRIVATE INVESTMENT

May 2007

Principal Author
James Stack, Goldman School of Public Policy, University of California, Berkeley

Contributing Authors
John Balbach, Cleantech Venture Network
Bob Epstein, E2
Teryn Hanggi, E2

ENVIRONMENTAL ENTREPRENEURS

ABOUT E2

Environmental Entrepreneurs is a national community of business people who promote sound environmental policies that stimulate economic growth. Working with its environmental partner, the Natural Resources Defense Council (NRDC), E2 works through bipartisan efforts to shape state and national policy. E2 serves as a champion on the economic side of good environmental policy by taking a reasoned, economically sound approach to environmental issues.

ABOUT CLEANTECH VENTURE NETWORK LLC

The Cleantech Venture Network® LLC, a Cleantech Group™ company, is a membership-based network that connects venture, corporate and institutional investors, entrepreneurs and service providers active in clean technology through related information products, online services and the Cleantech Venture Forum platform of events. The organization's mission is to accelerate the market adoption of venture innovation and cleantech investment. Cleantech Venture Network serves more than 1500 affiliate investor member firms worldwide. The organization has tracked more than $15 billion invested in cleantech ventures since 1999, of which over $600 million has been raised by companies presenting at Cleantech Venture Forums. Cleantech Venture Network serves the global markets via offices in Ann Arbor, Beijing, London, Toronto and San Francisco.

ABOUT THE AUTHORS

James Stack is completing a master's degree in public policy at the Goldman School of Public Policy at the University of California, Berkeley. He has worked on energy policy issues with the U.S. Government Accountability Office and the California Public Utilities Commission and holds a Ph.D. in mechanical engineering from the University of California, Berkeley. Beginning June 1, he can be reached at Freeman, Sullivan & Co. in San Francisco.

John Balbach is Managing Partner of the Cleantech Group™, LLC, parent company of the Cleantech Venture Network®, Cleantech Advisors™, Cleantech Search ™ and Cleantech Indices™. John also heads the Cleantech Group's Silicon Valley office. Prior to joining the Cleantech Group, John served as a venture capitalist, entrepreneur, advisor to world leaders, founder of international non-profits and senior policy maker in Washington, D.C. John's responsibilities have included crafting and financing U.S. national security programs, launching 18 early-stage companies and raising or advising on the placement of $350 million in capital for private and public companies.

Bob Epstein is an entrepreneur and engineer with a Ph.D. from the University of California at Berkeley. He is a co-founder of five companies: Sybase, New Resource Bank, GetActive Software, Zight, and Britton-Lee. Bob currently splits his professional time between his roles as co-founder of Environmental Entrepreneurs, Director New Resource Bank and Trustee of the Natural Resources Defense Council. Bob is Vice Chairman of California's Economic and Technology Advancement Advisory Committee for AB 32. Bob's community activities are focused on the environment, public education and opera.

Teryn Hanggi is the Program Manager for Environmental Entrepreneurs. Prior to her role at E2, Teryn provided environmental risk management consulting services to the oil and gas majors

where she assisted clients with identifying and implementing strategies that reduced financial risk and improved environmental performance. Teryn also worked at Accenture, a multi-national consulting firm, where she specialized in organizational change, human performance, and implementation of large scale IT systems.

ACKNOWLEDGMENTS

The authors would like to acknowledge the following people for the information, assistance, and guidance they provided in the development of this report:

Dan Adler (CalCEF)
Lisa Bicker (CalCEF)
Larry Gross (Altra)
Berl Hartman (E2)
Nicole Lederer (E2)
Ellen Pao (Kleiner Perkins Caufield & Byers)
Ron Pernick (Clean Edge)
Russell Pullan (Nomura, New Energy & Clean Technology Ventures)
Keith Raab (Cleantech Capital Group)
Joel Serface (Austin Clean Energy Incubator)
Bill Unger (Partner Emeritus, Mayfield Fund)

Thanks also go to the members of the following companies who participated in our cleantech investor survey:

@Ventures
3i Investments Plc
Battelle Ventures
Boston Cleantech Partners
Calvert Funds
Canaan Partners
Chrysalix Energy
Craton Equity Partners
CT Capital Group
CVC Sustainable Investments Limited
DFJ Element
Dow Chemical New Ventures
Emerald Technology Ventures AG
Garage Technology Ventures
General Motors Corporation
Global Environment Fund
Gorann LLC
Investor Growth Capital
John Deere
Lieberman Companies
Macquarie Funds Management
Mark A. Robinson Trust
Massachusetts Green Energy Fund
Mohr Davidow Ventures
New Island Capital
New Resource Bank
Nomura, New Energy & Clean Technology Ventures
RBC Dain Rauscher
Sakorn InVest AS
Sierra Ventures
Silicon Valley Bank
Starfish Ventures Pty Ltd
TechConnect
Technology Unlimited
TN Ventures
Verde Venture Partners
Volvo Technology Transfer
Willock Partners
Ziff Brothers Investments

TABLE OF CONTENTS

WHAT IS "CLEANTECH"?

The cleantech industry encompasses a broad range of products and services, from alternative energy generation to wastewater treatment to more resource-efficient industrial processes. Although some of these industries are very different, all share a common thread: they use new, innovative technology to create products and services that compete favorably on price and performance while reducing humankind's impact on the environment. To be considered "cleantech," products and services must:

- Optimize use of natural resources, offering a cleaner or less wasteful alternative to traditional products and services;
- Have their genesis in an innovative or novel technology or application;
- Add economic value compared to traditional alternatives.

The eleven cleantech categories, as defined by the Cleantech Venture Network, are[a]:

- Energy Generation
- Energy Storage
- Energy Infrastructure
- Energy Efficiency
- Transportation
- Water & Wastewater
- Air & Environment
- Materials
- Manufacturing/Industrial
- Agriculture
- Recycling & Waste

Firms in these categories may not always market themselves specifically as "cleantech," and investors who place capital into these firms likewise may not necessarily consider themselves to be "cleantech" investors. The Cleantech Venture Network (www.cleantech.com) tracks the activity of investors and entrepreneurs throughout the cleantech space and aggregates that information to create a holistic picture of the industry.

[a] Environmental Information Technology (IT) and Enabling Technologies had also been considered cleantech categories by the Cleantech Venture Network until October 2006.

Cleantech Segment	*Example Technologies*
Agriculture	Bio-based materials; farm efficiency technologies; micro-irrigation systems; bio-remediation; non-toxic cleaners and natural pesticides. *Does not include organic, health food, or natural health products.*
Air & Environment	Air purification products and air filtration systems, energy efficient HVAC; universal gas detectors; multi-pollutant controls; fuel additives to increase efficiency and reduce toxic emissions.
Materials	Biodegradable materials derived from seed proteins; micro-fluidics technology for conducting biochemical reactions; nano materials; composite materials; thermal regulating fibers and fabrics; environmentally-friendly solvents; nano-technology components for electronics, sensor applications and energy storage; electro-chromic glass; thermoelectric materials.
Energy	***Energy Generation*** Distributed and renewable energy generation and conversion, including wind, solar/photovoltaics, hydro/marine, biofuels, fuel cells, gasification technologies for biomass, and flywheel power systems.
	Energy Infrastructure Wireless networks to utilities for advanced metering, power quality monitoring and outage management; integrated electronic systems for the management of distributed power; demand response and energy management software.
	Energy Storage Batteries e.g. thin film and rechargeable; power quality regulation; flywheels; electro-textiles
	Energy Efficiency Energy management systems; systems that improve output of power generating plants; intelligent metering; solid state micro-refrigeration; control technology for HVAC systems; automated energy conservation networks.
Recycling & Waste	Recycling technologies; waste treatment; internet marketplace for materials; hazardous waste remediation; bio-mimetic technology for advance metals separation and extraction.
Manufacturing/ Industrial	Advanced packaging; natural chemistry; sensors; smart construction materials; business process and data flow mapping tools; precision manufacturing instruments & fault detectors; chemical management services.
Transportation	Hybrid vehicle technology; lighter materials for cars; smart logistics software; car-sharing; temperature pressure sensors to improve transportation fuel efficiency; telecommuting.
Water & Wastewater	Water recycling and ultra-filtration systems (e.g. UV membrane & ion exchange systems); sensors and automation systems; water utility sub-metering technology desalination equipment.

EXECUTIVE SUMMARY

The clean technology, or "cleantech," industry has the potential to be a major economic driver for the United States – one that can also provide competitive solutions to environmental challenges. We focus on the connection between cleantech and public policies at both the national and state levels. America's current advantage in cleantech is a huge asset, and one that must be protected and cultivated carefully. New research by Environmental Entrepreneurs (E2) and the Cleantech Venture Network shows continued strong growth in the U.S. cleantech industry. Smart public policy can help secure this advantage, while also addressing environmental and climate issues though solutions that will create jobs and provide significant economic benefits.

This is the third report on cleantech venture capital by Environmental Entrepreneurs (E2) and the Cleantech Venture Network®, a Cleantech Group™ company. A full copy of the report can be found online at www.e2.org. Previous reports from 2004 and 2006 can be found at www.e2.org and www.cleantech.com

Finding 1: Growth in cleantech accelerated in 2006, with significant activity in the public markets.

In 2006, cleantech became the third-largest North American venture capital investment category (11 percent of all venture investments), behind software and biotechnology. Total North American venture capital invested in cleantech companies reached $2.9 billion in 2006, an increase of 78 percent over the $1.6 billion invested in 2005.

A significant increase in investments during the second and third quarters of 2006 was driven by capital targeted for companies moving into production. Cilion, Altra, Bloom Energy, Renewable Energy Group, and Nanosolar—all of which represent new renewable energy technology or biofuels—collectively accounted for more than $600 million in investment in 2006. But this boom can also pose challenges: Companies with new technologies have difficulty accessing capital for manufacturing build-outs. While established technologies such as corn ethanol can rely on debt financing, the first thin film solar or cellulosic ethanol facilities cannot as readily access debt financing because of the higher risks associated with first production facilities. These companies are forced to either raise additional equity capital and/or look to government assistance. As part of the 2005 Energy Act, the Department of Energy granted six cellulosic facilities special financing of up to $385 million to help build their first production facilities that, in aggregate, should reach 130 million gallons per year.[1]

Cleantech is now an established investment category in the public markets. There are multiple stock indices including the Cleantech Capital Indices (CTIUS), WilderHill's ECO, Ardour Capital's Alternative Energy Indexes (e.g. AGINA, AGIGL), and Clean Edge's CELS and CLEN indexes. The 45 public companies that make up the Cleantech Index (CTIUS) have an aggregate market capitalization of over $300 billion. The performance of CTIUS over the past two years has been strong. In the two years through April 23, 2007, CTIUS has risen 38.9

percent, from 850 to 1180.6. This growth outpaced that of the S&P 500 Index (+28.6%), the NASDAQ Index (+29.9%), and the Dow Jones Industrial Average (+26.1%) over that period. After Sunpower and Suntech went public in late 2005, no fewer than seven photovoltaics companies (Canadian Solar, First Solar, PowerFilm, Akeena Solar, ReneSola, Trina Solar Limited, and Solarfun Power Holdings) went public in 2006. Recent IPOs in the biofuels sector have included Aventine Renewable Energy, Pacific Ethanol, Verasun, and U.S. BioEnergy. Perhaps because of this robust IPO market and the increase in publicly traded companies, the past two years in cleantech investing has moved from a specialty area of investment to one with broad participation from all major venture capital firms.

Finding 2: Energy prices, entrepreneurial talent, and advances in technology are industry factors accelerating growth.

Several important factors accelerated cleantech's growth in 2006:

- Sustained high oil prices have driven investor interest in alternative fuels. Most alternative fuel business plans are designed to compete with oil prices above $40 to $45 per barrel.
- As the cleantech market matures, it is attracting entrepreneurial management talent from other venture sectors – especially from information technology and biotechnology. These experienced entrepreneurs make it both easier to attract investments and more likely the company will develop into a viable business.
- Advances in technologies have been the basis for many new companies, including nano-materials used in thin-film solar and new chemistry in battery technologies.

Finding 3: Public policies at the national and state level have accelerated cleantech growth.

National and state policies have provided early foundations for many cleantech sectors, although investors do not expect those policies to continue in the long term. While the federal government has ramped up its efforts to promote ethanol, the current boom is primarily the result of states rapidly phasing out the MTBE gasoline additive and replacing it with ethanol. Venture activity in corn and cellulosic ethanol was a significant portion of investment growth in 2006, and investment in renewable electricity has been driven primarily by state renewable portfolio standards. Policies that provide long-term certainty are the most successful at driving business investment.

Finding 4: Climate change is beginning to influence growth in cleantech.

Many of the biggest news stories of the past few years have been tied directly to extreme weather phenomena – from disastrous hurricanes to record droughts, wildfires, heat waves, and melting polar icecaps. The public has grown increasingly aware of environmental issues, judging by public opinion polls showing rising public concern about global warming and energy security. Investors, sensing the level of public interest in these stories – and therefore an opportunity in the market – are beginning to invest in industries that reduce human impacts on the ecosystem**.** Climate change policies will play a key role in the growth of cleantech as it becomes increasingly apparent that products and processes that reduce greenhouse gases will see increased demand.

Finding 5: Cleantech can create thousands of new jobs.

Analysis from the University of California at Berkeley concluded that "the renewable energy sector generates more jobs per megawatt of power installed, per unit of energy produced, and per dollar of investment than the fossil-fuel-based energy sector." E2's own analysis found that every $100 million in venture investment generates an average of 2,700 new jobs. We estimate additional U.S. cleantech investment between 2007 and 2010 will be between $14 billion and $19 billion, resulting in 400,000 to 500,000 new jobs.

Policy Recommendations for Continued Cleantech Growth

The broad group of investors interviewed for E2's 2007 cleantech report consistently recommends three federal policies that will promote continued industry expansion:

1. a cap-and-trade system that sets limits on greenhouse gases,
2. a national renewable energy standard, and
3. increased public funding for research and development.

A cap on greenhouse gases would align public interest with the capital markets and send a clear signal that lower-carbon energy is more valuable to the nation than energy from high-carbon sources like fossil fuels. A firm, long-term cap-and-trade regime coupled with a national renewable energy standard would provide stability for the market development of cleaner energy regardless of a sudden or sustained decrease in fossil fuel pricing.

A full copy of this report can be found at www.e2.org.

CHAPTER 1

THE CLEANTECH BOOM

1.1 THE CLEANTECH INDUSTRY TODAY

Cleantech – also known as "clean technology" or "green tech" – is an industry whose phenomenal growth in the last three years has captured the attention of investors, the media, and policymakers alike. In fact, at the February 2007 Cleantech Forum XII in San Francisco, over 800 investors from the nation's, and moreover the world's, top venture, financial and legal firms showed up to meet other investors and learn about the latest cleantech companies and innovations. Only five years earlier, at the first Cleantech Forum, there were one tenth as many investors in attendance. Total venture capital in North America invested in cleantech companies reached $2.9 billion in 2006 making it the third largest venture category behind software and biotechnology. This was an increase of 78 percent over the $1.6 billion invested in 2005. U.S. investment in cleantech grew to $2.5 billion in 2006 – an increase of 88 percent over the $1.4 billion invested in 2005.[2]

The cleantech industry has been so ubiquitous over the past two years that a recent Google search for the term "cleantech" returned 925,000 hits. And a LexisNexis search for "cleantech" showed over 125 news articles written about the industry in the past six months, and 29 articles in the past month alone.[b]

U.S. Cleantech Industry by Sector

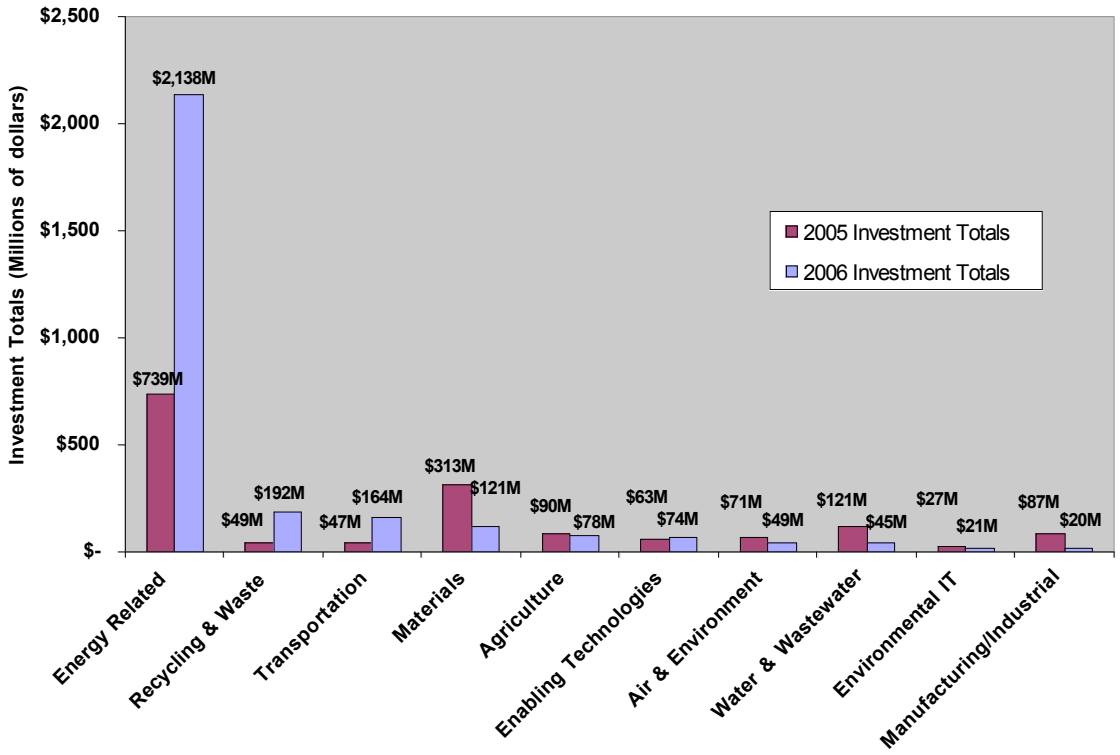
Taking a closer look at the eleven sectors that make up the cleantech industry, it becomes apparent that while the industry did well as a whole, its growth in 2006 was driven almost entirely by the energy technology sector. As Figure 1.1 shows, North American investments in clean energy generation, storage, efficiency, and infrastructure totaled $2.14 billion, almost three times as the amount invested in energy tech in 2005, and 33 percent larger than the investment total for the entire cleantech industry in 2005. Within the energy technology sector, clean energy generation dominated the other three sub-sectors (storage, efficiency, and infrastructure) with $1.3 billion in investments.

Clean Edge's 2007 Clean Energy Trends report also notes that the average deal size in the clean energy space was $17 million, indicating that, as with the total amount invested in cleantech, it was the energy technology space that was driving the strong growth in the average cleantech deal size last year.[3] Early reports from the first quarter of 2007 indicate that the energy sector

[b] LexisNexis and Google searches performed on April 3, 2007.

continued this trend, picking up roughly $2.2 billion in venture capital and private equity investments worldwide, according to New Energy Finance. Solar ($514 million) and biofuels ($205 million) led the way, helping the industry beat its first quarter tally from 2006 by 58 percent.[4]

Figure 1.1 ***North American Cleantech Venture Capital Investments by Industry Segment, 2005-2006 (Millions of dollars)***



A minor surprise in the 2006 cleantech investment totals was the water sector, which some investors have pegged as "the next big thing" for a couple of years now. There is still strong interest in the sector (as the strong turnout at a Cleantech Forum XII session on the subject attests) owing to the estimated $400 billion global market for water technologies. However, the lack of breakthrough technologies in the field has kept venture investors on the sidelines thus far, with investments in the sector actually falling from $121 million in 2005 to $45 million last year.

U.S. Cleantech Investment by Region

Just as there were large disparities in the size and growth rates of the various cleantech sectors in 2006, there was also tremendous variation in the geographic distribution of the investments across the country, and the world. As with U.S. venture capital investments as a whole, California led the way in cleantech venture investments in 2006, bringing in a total of $1.13 billion (including $510 million in the third quarter alone), a 127 percent increase from its 2005 total – expanding the lead the West Coast (California and Hawaii) already held over the other regions of the country.

In the 2006 version of this report,[5] the 2005 investment data showed that the Northeast region was quickly catching up to the West Coast, trailing it by less than 20 percent in total cleantech investments and with virtually the same number of deals and the same amount of year-over-year growth in investments. The 2006 data, however, show that while the Northeast is still the second

strongest region in the country in cleantech investments, the West Coast received more than twice as much venture capital. As a result, the West Coast widened its lead on the rest of the country, expanding its share of total cleantech investments by 8 percentage points, from 37 percent to 45 percent, as Figure 1.2 demonstrates.

Figure 1.2 ***U.S. Cleantech Venture Capital Investments by Region, 2005-2006 (Millions of dollars)***

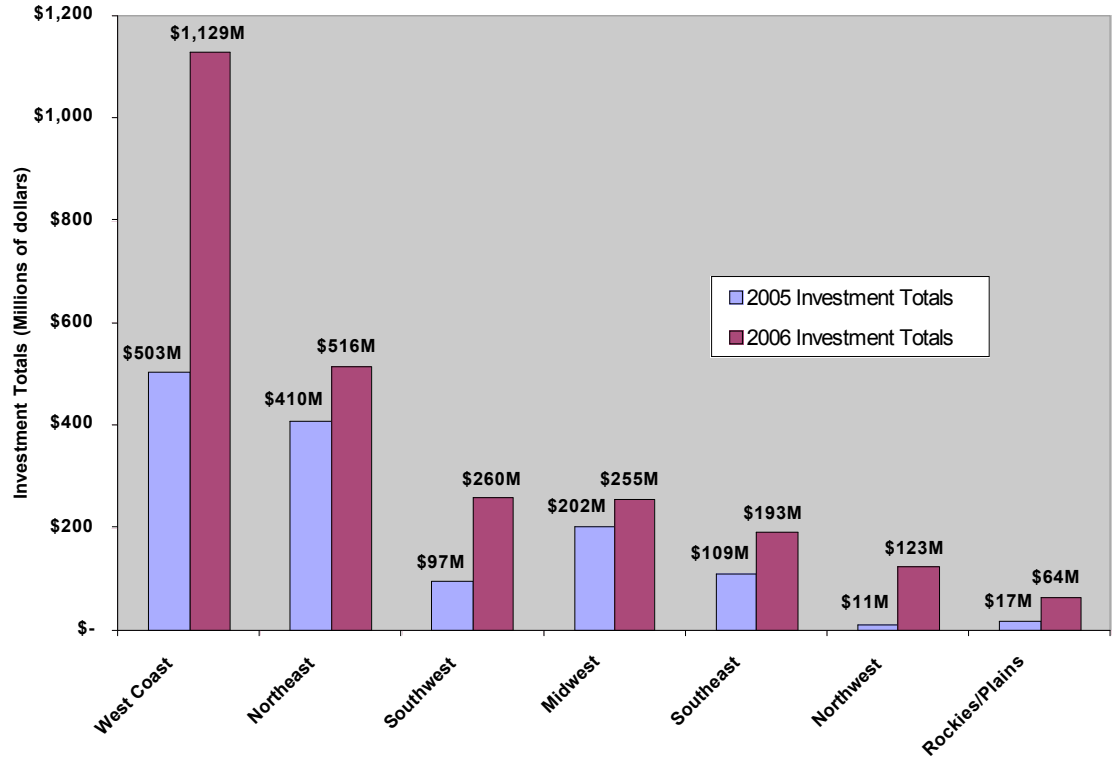
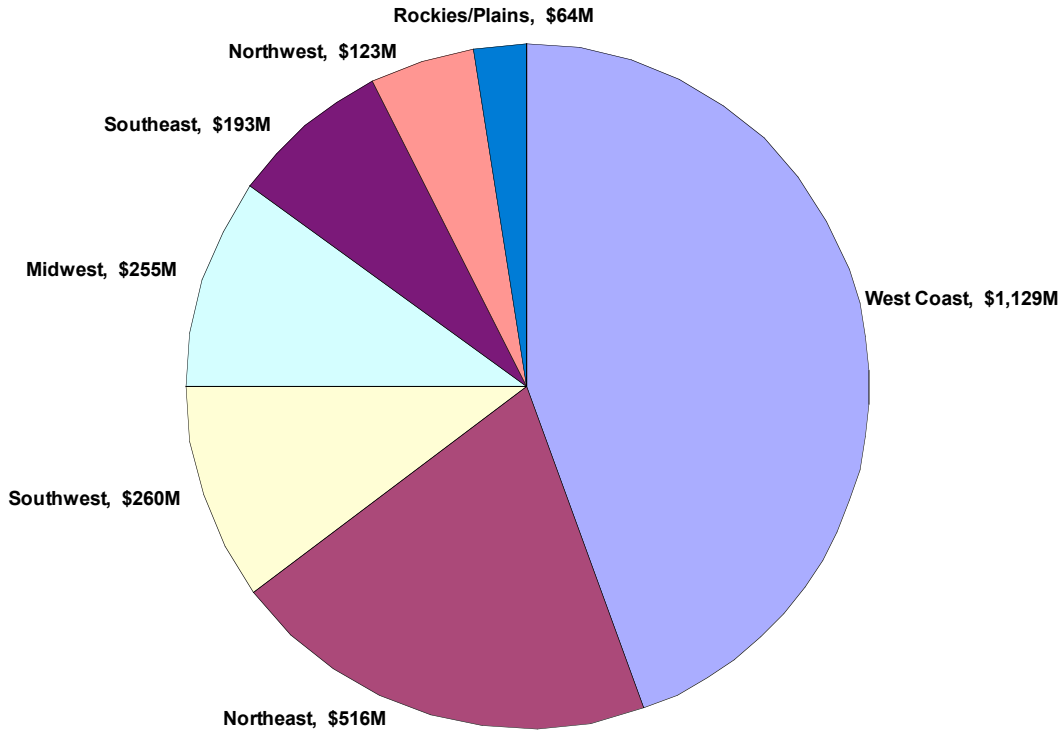
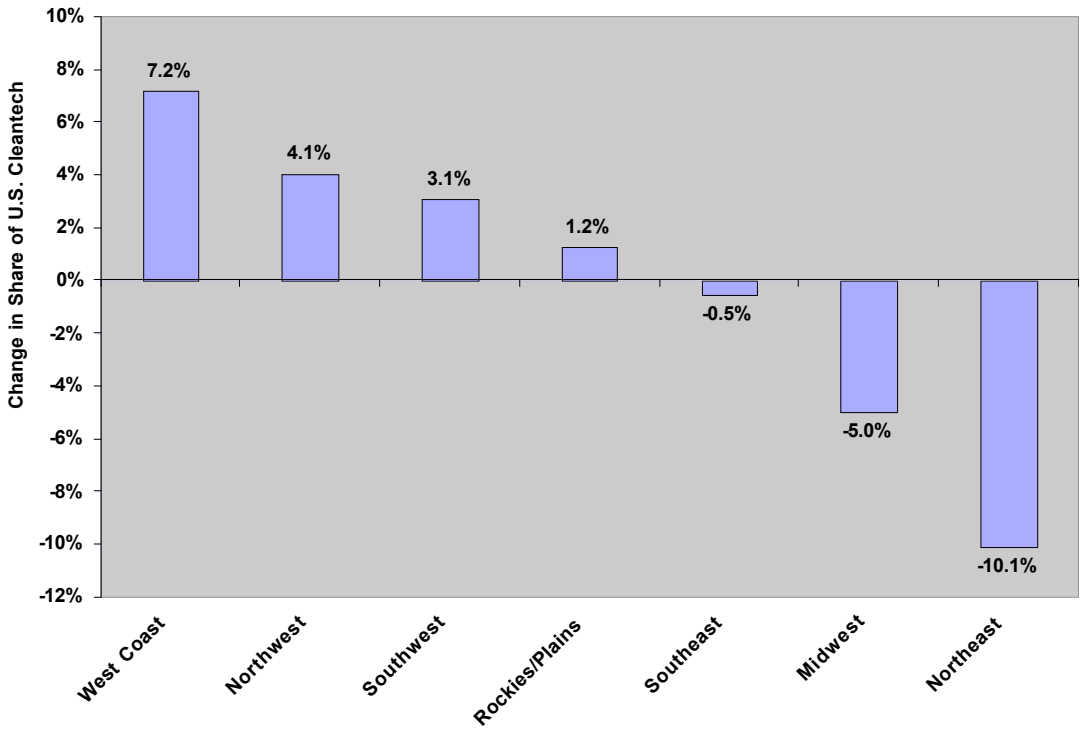


Figure 1.3 ***2006 U.S. Cleantech Venture Capital Investments by Region (Millions of dollars)***



The other regions to increase their shares of the cleantech pie were the Northwest (from 1 percent to 5 percent) and the Southwest (from 7 percent to 10 percent), which moved from fifth place into third. Although the Northeast's share of cleantech investments fell the most this year (from 30 percent to 20 percent) it still received nearly twice as much in cleantech investments as the next strongest region (the Southwest), and there appear to be no other new cleantech hubs on the horizon to rival the Boston/Cambridge area (which is currently second only to the Bay Area in California).

Figure 1.4 ***Change in Share of U.S. Cleantech Venture Capital Investments, 2005 to 2006***



With only a slightly higher number of deals than the Northeast, the West Coast's substantial absolute advantage in funding is attributable to its average deal size being almost twice as large as the Northeast's average. As the table below shows, average deal sizes rose significantly across all regions of the country last year, as investor enthusiasm for cleantech grew. The Southeast and Midwest, in fact, had significantly *fewer* total deals last year compared to 2005, but both still saw their investment totals jump.

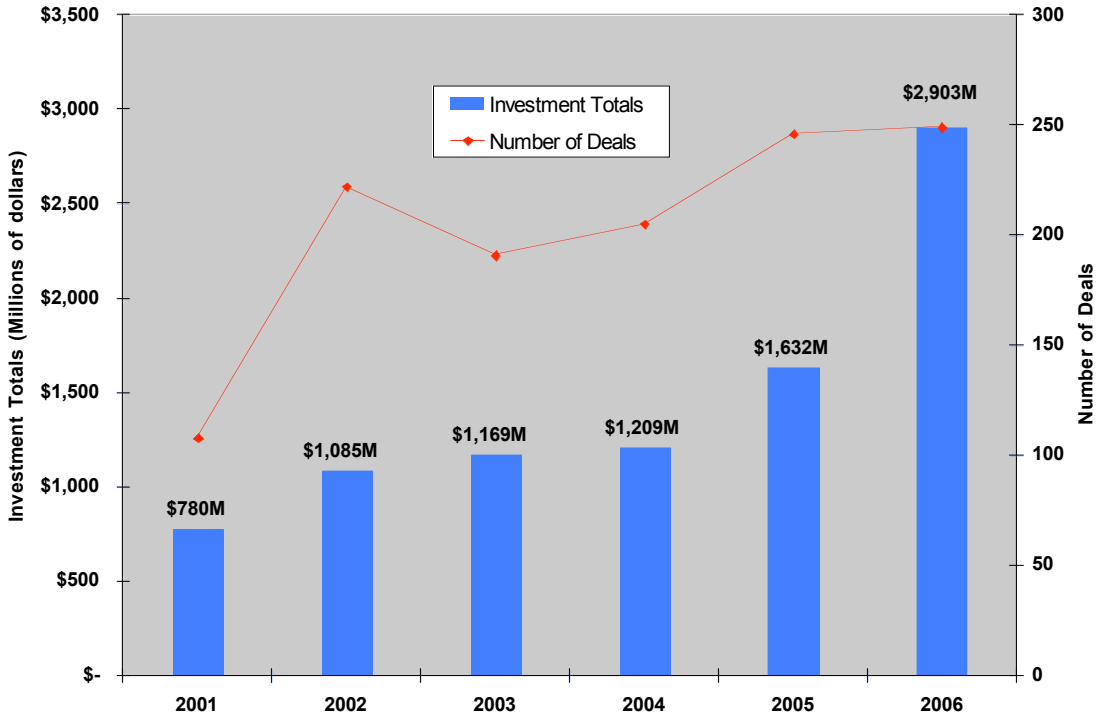
2005-2006 U.S. Cleantech Investment Totals and Deals

U.S. Regions	2006 VC Total	2005 VC Total	2006 Deals	2005 Deals	2006 Avg Deal Size	2005 Avg Deal Size
West Coast	$ 1,129,257,570	$ 502,517,217	67	59	$ 16,854,591	$ 8,517,241
Northeast	$ 515,654,231	$ 410,006,837	56	58	$ 9,208,111	$ 7,069,083
Southwest	$ 259,970,543	$ 96,573,000	19	16	$ 13,682,660	$ 6,035,813
Midwest	$ 255,065,662	$ 202,376,606	21	31	$ 12,145,984	$ 6,528,278
Southeast	$ 193,100,000	$ 109,478,485	10	18	$ 19,310,000	$ 6,082,138
Northwest	$ 123,200,000	$ 10,779,000	9	6	$ 13,688,889	$ 1,796,500
Rockies/Plains	$ 64,034,339	$ 17,208,285	10	5	$ 6,403,434	$ 3,441,657
U.S. Total	**$ 2,540,282,345**	**$ 1,348,939,430**	**192**	**193**	**$ 13,230,637**	**$ 6,989,323**

Trends in the U.S. Cleantech Industry

As Figure 1.5 below shows, 2006 was the latest in a series of increasingly strong years for the cleantech industry. This steady growth in cleantech – and particularly in energy technology – bodes well for the industry, and for the U.S. In fact, Clean Edge estimates that revenues from the clean energy industry (which it defines as biofuels, wind power, solar photovoltaics, fuel cells, and hydrogen) will increase fourfold from an already strong $55 billion last year to $226 billion by 2016.[6] They project strong increases in all five sectors, with the greatest revenue in ten years coming from biofuels ($81 billion), photovoltaics ($69 billion), and wind ($61 billion).

Figure 1.5 ***Annual North American Cleantech Venture Capital Deals and Investment Totals, 2001 to 2006 (Millions of dollars)***

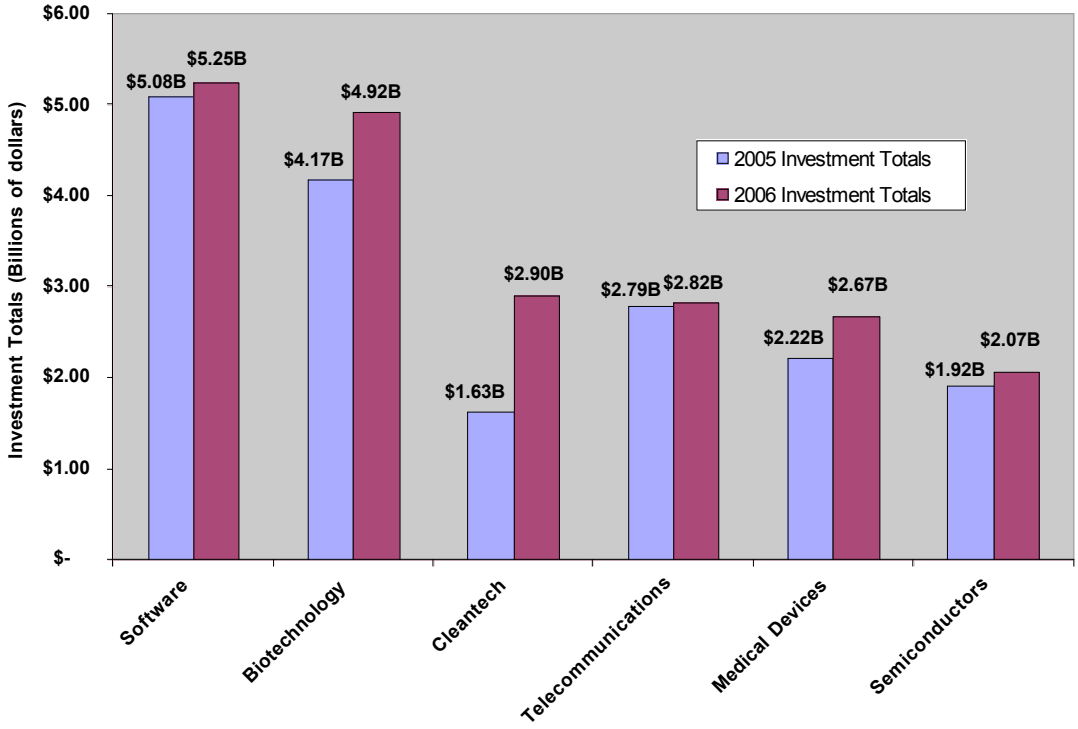


A survey of cleantech investors by Jefferies & Company at Cleantech Forum XII in February 2007 found a similarly bullish attitude toward solar power: 40 percent of investors predicted solar would contribute more to global electricity needs in 2020 than hydro power, wind, or geothermal (all of which currently generate far more electricity than solar). These investors were likewise optimistic about the future of biofuels, with a full 75 percent predicting that the U.S. will consume at least 35 billion gallons of renewable fuels by 2017, meeting the goal the President set in his 2007 State of the Union address.[7]

1.2 NORTH AMERICAN VENTURE CAPITAL INVESTMENT

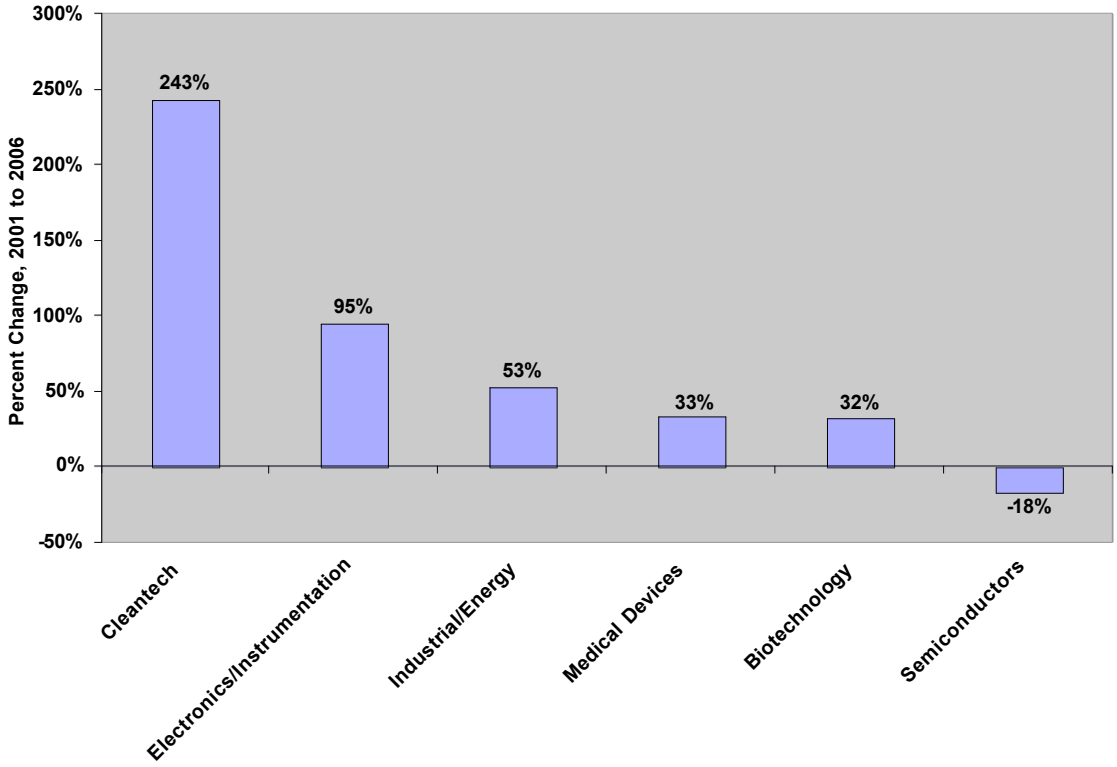
As alluded to above, 2006 was a banner year for the cleantech industry – with total venture investments surpassing those of the medical devices, telecommunications, and semiconductor sectors – all of which it had trailed in 2005. Venture investments in cleantech firms in North America totaled $2.9 billion, a 78 percent increase over the same total in 2005, and a 243 percent increase since 2001. This total also represented 11 percent of all North American venture capital investments for the year ($27.0 billion),[8] making cleantech the third largest venture capital category – after only software and biotechnology.

Figure 1.6 ***Top 6 North American Venture Capital Industries, 2005 to 2006 (Billions of dollars)***



In fact, since the economic downturn of 2000-2001, cleantech is one of the few U.S. industries to experience real growth in venture investments, as Figure 1.7 demonstrates. While U.S. venture capital investments as a whole were off by 33 percent in 2006 compared to 2001, investments in American cleantech companies were up 243 percent in that time – more than two and a half times the growth rate of the next strongest industry (electronics/instrumentation) over that period.[9]

Figure 1.7 ***Top 6 U.S. Venture Capital Industries, 2001 to 2006 Percentage Change***



Venture Capital and the Product Development Cycle

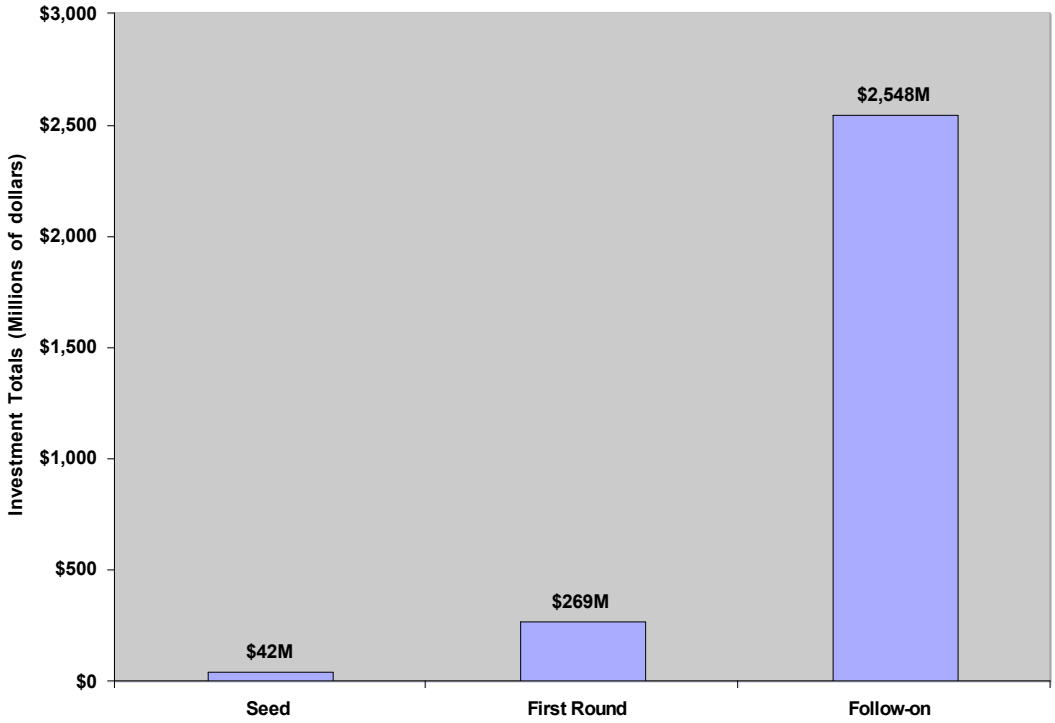
A product's journey from the laboratory to installation at a customer's site tends to be long and difficult, and the path is littered with failed business ideas. Venture capitalism supports many early-stage companies, providing needed funds that help take technologies and products from conception to profitability. The typical product development process proceeds from the basic R&D stage, where an idea is first tested out, to several rounds of venture capital financing (a seed round, a first round, and one or more follow-on rounds) that help a company cultivate a marketable product. Because these companies in general have no sales revenue at this stage, venture capital investments are very high risk. For that reason, venture capitalists tend to look for companies that have the potential to deliver huge returns, even revolutionize an industry. As a result, venture capital investments act like a barometer of innovation and entrepreneurial activity.

In addition to providing much needed project financing, venture capitalists also bring business and industry-specific knowledge to their portfolio companies that helps them become profitable. In exchange for all of this assistance, venture capitalists hope to "exit" (sell their share) in three to eight years, with successful companies returning five to ten (or more) times their initial investment. Of course, with such high risks involved not all venture-backed companies succeed. A successful venture-backed company is considered one that either goes public with significant revenues or is acquired by an existing public company, enabling the venture capitalist to exit with a significant return on their original investment.

Figure 1.8 below shows the stage at which the cleantech venture capital investments were made in 2006. While it is common for follow-on financing to exceed seed round and first round financing (in these later rounds companies tend to have a greater need for capital, and lower risk for investors), the tremendous magnitude of follow-on financing seen in 2006 is perhaps an

indication that we are about to see a rash of cleantech IPOs in the coming years, as companies graduate from later-round venture financing to public financing.

Figure 1.8 ***2006 North American Cleantech Venture Capital Investments by Funding Stage (Millions of dollars)***

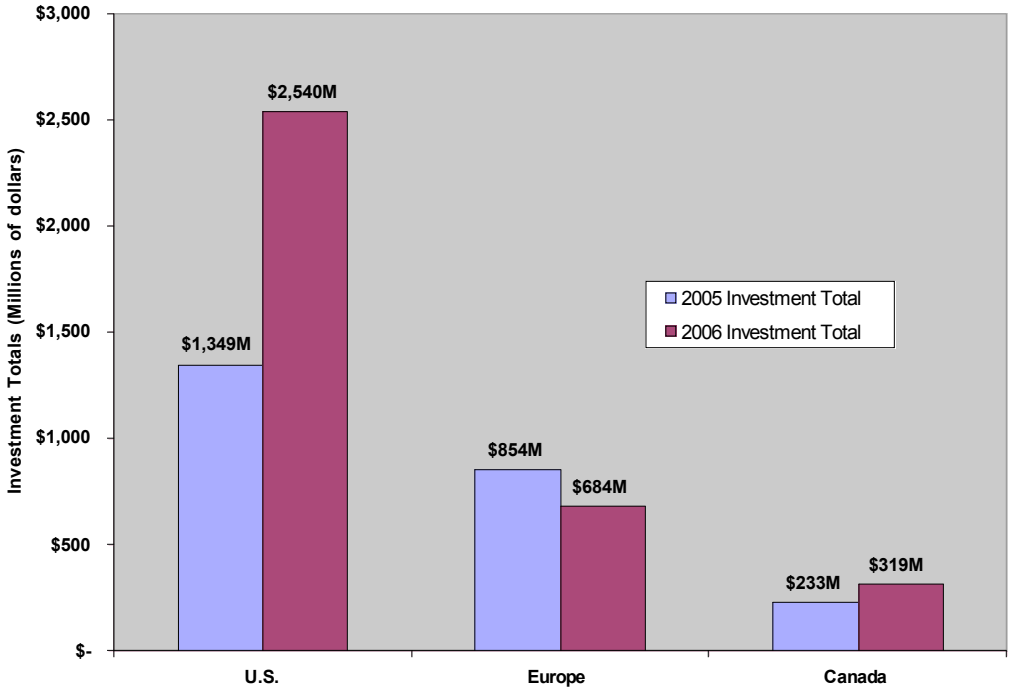


The comparative lack of seed funding (or angel funding) suggests that some early-stage cleantech companies may still be struggling to reach the point where significant venture investments become possible. Public policy could play an important role in helping promising start-ups caught in this funding "Valley of Death" to survive. For example, the California Clean Energy Fund recently announced it is developing a program to provide seed funding.[10]

1.3 CLEANTECH IN THE GLOBAL MARKET

Although the U.S. is not the only country benefiting from the boom in the cleantech industry in recent years, it is far and away the leader in cleantech, in terms of total investment and growth. Among other regions in the world, Europe and Canada both have developing cleantech industries to rival the U.S., bringing in approximately $680 million and $320 million in venture capital, respectively, in 2006. But 2006 belonged to the U.S., as its 88 percent growth over 2005 far outpaced the performances of Canada (which grew by a comparatively modest 37 percent last year) and Europe (which actually saw a 20 percent decline in investment).[11]

Figure 1.9 ***Cleantech Venture Capital Investments in the U.S., Europe, and Canada, 2005 to 2006 (Millions of dollars)***



Although the U.S. is no longer the world leader in two important clean energy fields – it ranks third in installed wind power production behind Denmark and Spain,[12] and third in photovoltaic power installed behind Germany and Japan[13] – its continued growth in investments in clean energy and other clean technologies suggests that significant growth may be in store for U.S. markets in these and other cleantech areas in the years to come.

Cleantech Companies in the Public Market

The existence of a healthy public market is a key factor in inducing venture capital to invest in cleantech, as it provides investors with a level of assurance that the companies in which they invest will ultimately have the ability to go public. The growing public market for cleantech over the past two years is clearly demonstrated by the emergence of indices tracking the public cleantech companies. In North America alone there are already a half-dozen stock indices tracking cleantech companies, including the Cleantech Capital Indices LLC Cleantech Index (CTIUS), WilderHill's ECO, Ardour Capital's Alternative Energy Indexes (e.g. AGINA, AGIGL), and Clean Edge's CELS and CLEN indexes. The 45 public companies that make up the Cleantech Index (CTIUS) have an aggregate market capitalization in excess of $300 billion.[14] Moreover, the performance of CTIUS over the past two years has been strong. In the two years through April 23, 2007, CTIUS has risen 38.9%, from 850 to 1180.6. This growth outpaced that of the S&P 500 Index (+28.6%), the NASDAQ Composite Index (+29.9%) and the Dow Jones Industrial Average (+26.1%) over that period.

1.4 DIFFERENT FROM PREVIOUS GENERATIONS OF "ENVIROTECH"

At various times in the recent past, investors have shown serious interest in environmental technologies. This was especially true in the 1970s, when global instability led to spikes in the price of oil, and when major public concern about urban smog led the government to enact the first serious clean air regulations. These events provided the impetus for the creation of a series of new industries – solar power, wind power, alternative fuels, hazardous waste remediation, and power plant pollution "scrubbers," among others. The economic drivers were primarily public policies that either required pollution control equipment or required the development of alternative energy sources that were not initially expected to be cost competitive. Those that depended on government regulations never achieved true market acceptance beyond the minimums set by these regulatory mandates. Those that depended on high energy prices died off when prices collapsed again.

Today's cleantech industry is different. Purchasers of cleantech products and services are for the most part responding to the economic advantages of the products. Those advantages are in part due to the competitive value of the products and in part due to government policies which either require a certain performance characteristic (e.g. energy efficiency target or pollution reduction) or give an incentive (e.g. excise tax credit for biodiesel). Many past technologies were developed in response to government mandates focused on environmental compliance (e.g. NOx or SOx emission reductions) and provided no direct benefit to the purchaser.

Today's cleantech sectors, on the other hand, while benefiting from government policies, have responded to market demand for technologies that will address real business opportunities for better quality or lower costs. In addition, today's industry has proved to be more mature than that of the past, with a much greater ability to compete with traditional alternatives on a cost and performance basis. The big difference between the current generation of environmental technologies and those of the past is that the *modus operandi* of today's cleantech companies is first to provide competitive returns for investors, and second to deliver solutions to global environmental problems.

While world oil prices and environmental concerns continue to be major drivers of cleantech investments, today's market presents an almost ideal environment for the industry to thrive in. Several of the primary drivers of the cleantech industry's recent growth – all of which show promise of sustaining themselves over the long term, unlike past industry drivers – are:

1. Energy Prices – The price of oil reached an all-time high of $78.40 per barrel on July 13, 2006, pushing the average price of a gallon of gasoline over $3 per gallon in the U.S.[15] Coincidentally or not, this surge in gasoline prices paralleled a similar surge in venture investments in the biofuels industry. Investors were perhaps responding to the great importance consumers placed on the gas price issue, searching for a product that might satisfy customers' desire for a product to turn to instead of gasoline, and capture a slice of the massive oil market. For example, an April 2006 ABC News poll of 1,015 adults found that 70 percent said high gas prices had caused financial hardship in their household.[16] And a June 2006 USA Today/Gallup poll, 73 percent of respondents said the high price of gas would be "very important" or "extremely important" in determining their vote in the 2006 Congressional election.[17]

2. High-tech Knowledge Base and Experience – In 2006, California received more than $1.1 billion in cleantech investment, roughly 44 percent of the total for the U.S. Of that amount, Silicon Valley received about 60 percent.[18] Many of the companies in California and elsewhere receiving those investments have management that has moved from other venture-backed industries to cleantech. They are attracted to cleantech for much the same reason that they got involved in software, biotech, or communications startups: the ability to have large-scale, significant impact in a complex and dynamic market. The knowledge and skills these entrepreneurs gained in other industries are also being put to use in the current cleantech boom; the region's current strength in nano-materials and solar power, for example, is due in part to its experience in the silicon/semiconductor industry. The $390 million in venture capital invested in California biofuels companies in 2005 and 2006 is likely due in part to a similar spillover effect from the state's strong biotech industry.

3. Technology Advances – Like computer CPUs doubling in processing speed every 24 months, the performance of clean technologies also seems to march forward in step with Moore's Law. The past few years have seen major advances in non-silicon based solar power technologies (e.g. thin-film solar panels, concentrating photovoltaics, and solar thermal power plants) that have increased the market potential of solar power. Likewise, new batteries could enable hybrid and electric vehicles that would allow electricity to compete as a transportation fuel. The advances in batteries have been driven by the cell phone industry and consumer need for a battery that is lightweight, can be recharged many times, and holds a large electric charge for its volume. Electric vehicles need exactly the same characteristics. For example, Tesla Motors introduced in 2006 an all-electric vehicle based on standard batteries from the consumer products industry.[19]

4. Global Environmental Pressures and Public Awareness – Many of the biggest news stories of the past few years have been tied directly to extreme weather phenomena – from disastrous hurricanes (Katrina in particular) to record droughts, wildfires, and heat waves (such as the one that killed an estimated 35,000 people in Europe in 2003) to melting polar icecaps. The public has clearly grown increasingly aware of environmental issues, judging by public opinion polls showing rising public concern about global warming and energy security. Investors, sensing the level of public interest in these stories – and therefore an opportunity in the market – are beginning to invest in industries that reduce human impacts on the ecosystem.

5. U.S. Policies – Investors tend to keep a close eye on policies that might impact the industries in which they invest, and many these days have recognized the very strong likelihood that significant climate change legislation – for example, a mandatory national carbon cap-and-trade system – will be passed within a few years, significantly expanding the markets for cleaner technologies. State and local initiatives also provide assurances that a long-term market will exist. California's Low Carbon Fuel Standard, for example, is expected to triple the size of the state's renewable fuels market, which has made the state a magnet for biofuels investments ($390 million of the $850 million invested in biofuels from 2005 to 2006 went to California). Another example is Starwood Hotels & Resorts, which has begun

installing fuel cell systems in its facilities in states where it is able to take advantage of clean energy incentive programs. It recently installed four 250 kW fuel cells in its Sheraton San Diego Hotel & Marina, subsidized by the California Public Utilities Commission's Self Generation Incentive Program.[20]

6. Capital Markets Acceptance – While the cleantech market originally consisted mostly of specialist investment firm and people with a strong environmental focus, this is no longer the case. With many of the world's major public and private equity investment entities committing capital to cleantech – and several market indexes in existence that focus exclusively on cleantech companies – the industry can now be considered mainstream.

CHAPTER 2

BEHIND THE BOOM

2.1 REASONS FOR THE CLEANTECH BOOM: WHAT INVESTORS HAVE TO SAY

In February and March of 2007, we surveyed 41 cleantech investors who have extensive knowledge of the industry about the reasons for cleantech's growth, and also on their thoughts about the industry's future. (A copy of the survey is provided in Appendix 1.) This group of investors together controls approximately $3 billion in committed capital, and, at the time of the survey, had plans to devote an additional $800 million of raised capital specifically to cleantech.

As the following results demonstrate, this group of cleantech insiders has strong beliefs that federal and state policies have had an impact on the recent success of the cleantech sector, and could have an even stronger effect in the future:

- 84 percent of respondents (27 of 32) surveyed think a proactive environmental public policy stance can be a driver in bringing new cleantech businesses to a state or region. (Six percent responded negatively, while 9 percent indicated they were unsure.)

- 72 percent of respondents (23 of 32) surveyed said that current federal policies regarding cleantech affect their likelihood of investing in U.S. companies in some way. (Twenty-two percent responded negatively, while 6 percent said they were unsure.)

- The vast majority of respondents (86 percent, or 25 of 29) said that high energy prices had been 'critical' (45 percent) or 'important' (41 percent) in influencing their investment decisions.

- The second largest factor influencing investment decisions was growing public awareness of climate change, with 79 percent of respondents (23 of 29) saying it was a critical or important factor.

- 65 percent of respondents (19 of 29) also said that state renewable portfolio standards had been important or critical to their investment decisions. Fifty-two percent (15 of 29) said the same of the federal Renewable Fuels Standard.

- Asked which states or regions, through policies and other efforts, do the best job of encouraging cleantech start-up companies, 69 percent (25 of 36) of investors cited

California. Twenty-five percent (9 of 36) mentioned New York, while 17 percent (6 of 36) cited Massachusetts and Pennsylvania.

Figure 2.1 ***Factors Influencing Cleantech Investments: Survey Responses (N = 29)***

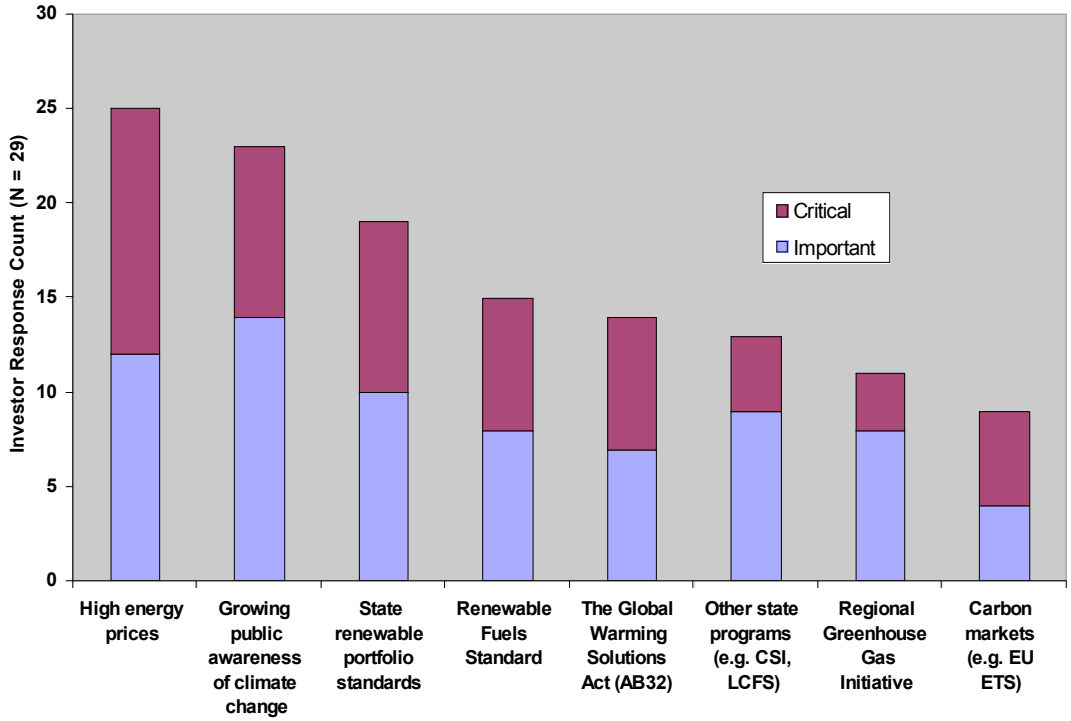
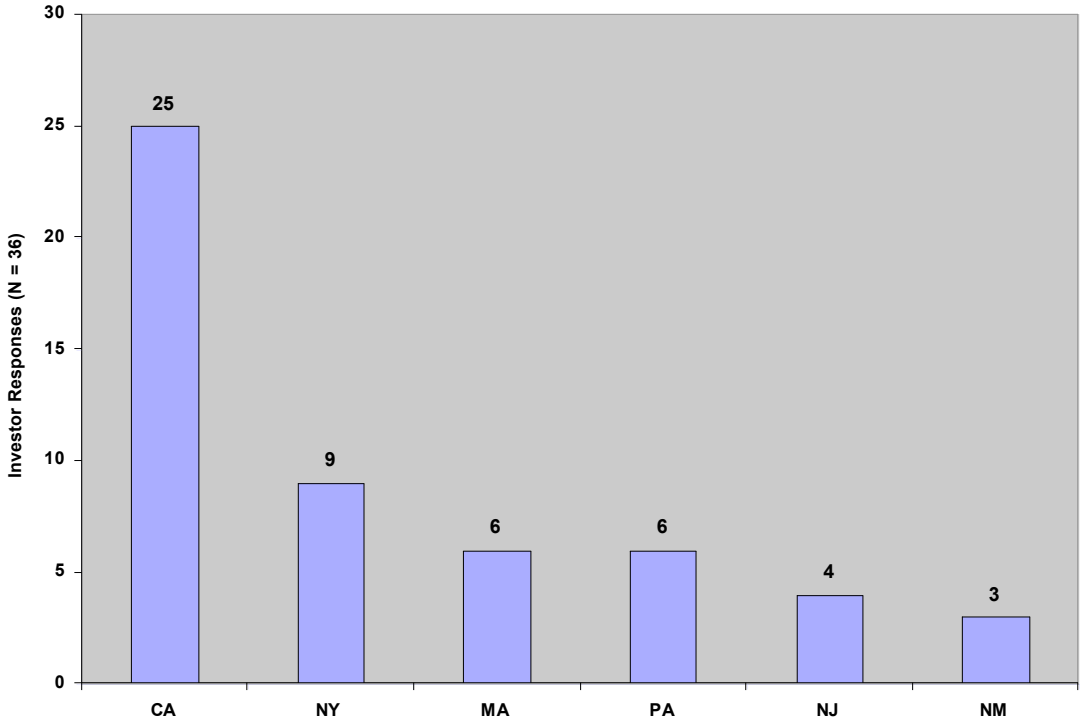


Figure 2.2 ***States Best at Encouraging Cleantech Start-ups: Survey Responses (N = 36)***



2.2 THE ROLE OF PUBLIC POLICY

If, as the survey of cleantech investors suggests, current policies have affected the sector, which policies have had the most positive impact? In broad terms, current policies affecting the cleantech industry can be grouped into four categories: those that ensure market demand, those that create markets for environmentally-friendly attributes or credits, those that fund or subsidize cleantech products or services, and tax/tariff policies. Brief descriptions and some examples of each type of policy are discussed below:

Ensuring Market Demand (Directly & Indirectly)

The most common types of policies in this category are Renewable Fuel Standards (RFS) and Renewable Portfolio Standards (RPS). At present, at least 23 different states and the District of Columbia have some form of RPS requiring that a certain amount of its electricity usage come from renewable sources (although there are several different definitions of "renewable" and many different energy level requirements). While there is currently no national RPS, the state-level RPS requirements provide assurances to clean energy companies that there will always be a substantial market (a "demand floor") for their product – no matter how low the cost of fossil fuel-derived energy falls. By not mandating a specific form of clean energy, state RPSs also assure that the many forms of clean energy will compete with one another on the basis of cost, performance, and reliability.

The federal Renewable Fuels Standard performs a similar function for the various forms of renewable fuels (such as ethanol, biodiesel, and butanol). Established by the 2005 Energy Policy Act, the RFS requires that U.S. vehicles consume a minimum of 7.5 billion gallons of renewable fuel annually by 2012 – up from about 1.8 billion gallons in 2001.[21] By ensuring that such a substantial market will exist far into the future, the RFS has helped propel the tremendous growth of the biofuels industry – which, as a result, is likely to exceed the 2012 RFS goal several years early. As part of the 2005 Energy Act, the Department of Energy granted six cellulosic facilities special financing of up to $385 million to help build their first production facilities that, in aggregate, should reach 130 million gallons per year.[1]

In addition to the indirect methods described above for ensuring the existence of cleantech markets, government can also directly stimulate market demand by leveraging their own buying power. By making large cleantech purchases, governments not only increase the market size for such products (which helps bring their prices down through economies of scale), they also set a strong example for ordinary consumers that cleantech purchases are good for society.

Markets for Emissions Credits

One of the most commonly cited proposals for dealing with climate change is establishing an emissions "cap-and-trade" system, whereby greenhouse gas emissions would be "capped" at a given level for different companies, and those who exceed their allotment are required to buy credits to cover their surplus from those who emit less than their allotment. But a necessary precondition for such a system, of course, is the existence of a market for the trading of credits. Rather than waiting for federal action to take place, a small number of states and other independent actors have banded together to create emissions markets – placing an actual value on greenhouse gas emissions for the first time in the U.S.

In 2005, for example, the governors of seven states from the Northeast and Mid-Atlantic regions (Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont[c]) established the Regional Greenhouse Gas Initiative (RGGI), the country's first mandatory cap-and-trade program, thus creating a carbon marketplace designed to reduce the region's greenhouse gas emissions by 10 percent by 2019.[22] Each state agreed to incrementally reduce emissions from its power plants over time, in the process creating incentives for companies to adopt cleaner, more efficient technologies.

Far from putting participating states at an economic disadvantage relative to non-participating states, a Federal Reserve Bank of Boston analysis of the effects of RGGI concluded that the program will likely have a "modest positive impact on gross regional product, personal income, and employment."[23] In particular, RGGI is likely to accelerate growth for some cleantech companies in the region. Already, Massachusetts is home to a major cleantech hub in the Boston/Cambridge area and was the second largest recipient of cleantech investments in 2005 and 2006.

It should also be noted that RGGI's cap-and-trade system is building on the experience of prior cap-and-trade systems including the U.S. sulfur dioxide trading program and the European Union's Emissions Trading Scheme (ETS). The ETS has been operating since January 2005 as the world's largest greenhouse gas cap-and-trade system. According to the World Bank, this system dominated the global market for carbon, which grew from $11 billion in 2005 to $21.5 billion in just the first three quarters of last year.[24]

Subsidies and Investments

Nationwide, dozens of programs exist to finance research into clean technologies – from the U.S. Department of Energy's R&D investments to state programs like California's Public Interest Energy Research (PIER) program and the New York State Energy Research and Development Authority (NYSERDA). These "public benefits" programs are typically financed by tax dollars or surcharges on rate payers. But far from being a cost, the programs have demonstrated an ability to generate a positive return, which ultimately lowers customers' bills. A study by the RAND Corporation on California's energy efficiency program showed the program resulted in an increase in the state's economy of $875 to $1,300 per capita between 1977 and 2000, a 40 percent decrease in air pollution emissions from stationary sources and a reduced energy burden on low-income households.[25]

In spite of such benefits, federal research and development funding for energy has fallen by half since the late 1970s – even while overall federal R&D spending has increased, according to Gregory Nemet and Daniel Kammen of the University of California at Berkeley.[26] Meanwhile, energy R&D investment by private companies in the U.S. fell by 50 percent between 1991 and 2003. As a result, total energy R&D are now only 2 percent of all R&D investments in the U.S. – compared to 10 percent of all R&D expenditures in 1980. At a time of critical environmental needs – and market opportunities – public sector

Energy R&D investment by private companies in the U.S. fell by 50% between 1991 and 2003. As a result, total energy R&D are now only 2% of all R&D investments in the U.S. – compared to 10% of all R&D expenditures in 1980.

[c] With momentum growing for carbon regulations, the governors of Massachusetts and Rhode Island also committed their states to join RGGI early this year. Maryland will become a RGGI member later this year as well – bringing the total to ten member states – after its legislature passed the Healthy Air Act in 2006, requiring it to join in 2007.

investment in R&D could play a much greater role than it currently does in spurring innovation and improving the competitiveness of the U.S. cleantech industry.

A handful of new, innovative, non-governmental programs have also appeared in recent years. In California, for example, the two largest public pension funds in the country, CalPERS and CalSTERS, worked with the state Treasurer's office to launch the Green Wave Initiative in 2004, setting aside $450 million of capital to invest in cleantech companies.[27] The decision to establish the program was based on the expected higher rate of returns on the investments. This announcement by two highly respected investment funds not only provided investments into cleantech firms but also sends a strong signal to other states and the market as a whole that this sector presents strong investment opportunities.

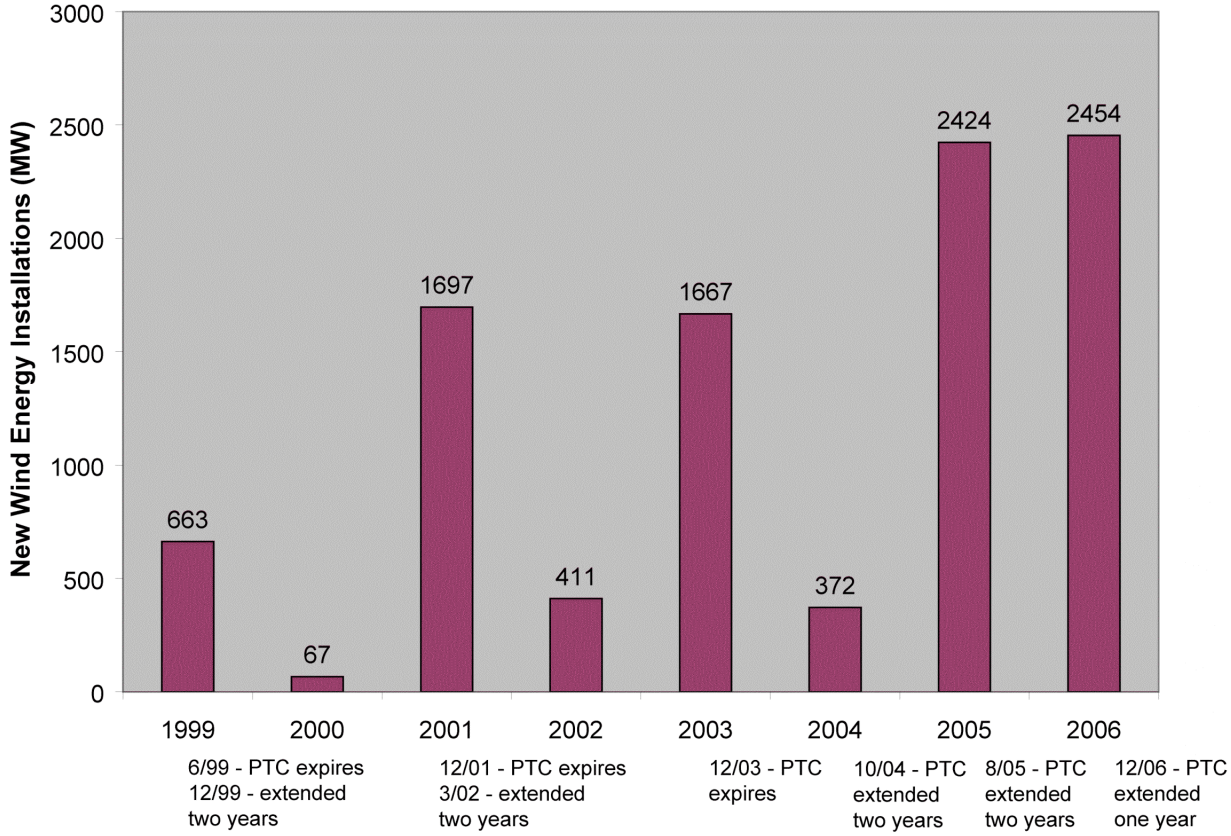
Taxes and Tariffs

This final category represents an array of programs that often impact the industry in powerful and complex ways. For example, there is strong industry consensus that the biofuels boom of 2005-2006 was aided considerably by the federal Volumetric Ethanol Excise Tax Credit (VEETC) of $0.51 per gallon to ethanol producers[28] (as well as the $1 per gallon credit for renewable biodiesel producers[29]), and the $0.54 per gallon tariff on ethanol imports.[30]

Although these measures have provided direct boosts to the bottom-lines of ethanol and biodiesel producers in this country, while also providing a strong degree of trade protection, they are also sometimes implicated for helping to boost the retail price of ethanol, which soared to nearly $4 per gallon in the summer of 2006.[31] However, it should be noted that because the U.S. primarily uses ethanol as an additive to gasoline, replacing MTBE, the rapid phase-out of MTBE created such strong and sudden demand that the retail price would have soared with or without the VEETC and import tariff. The high demand for ethanol had the unintended consequence of increasing the global price of corn – and drew some public scorn and frustration over the financial hardship this caused.

The renewable energy Production Tax Credit (PTC) is equally important to the success of the wind energy industry, which faces both economic and technical hurdles in competing with traditional fossil power sources. But unlike the VEETC and the ethanol import tariff, which have remained in place for many years, the PTC has suffered a yo-yo like fate, lapsing and being renewed approximately every two years – to the consternation of investors and companies, who find themselves unable to plan ahead in such an uncertain environment. As a result of this policy uncertainty, the wind industry has experienced a dramatic boom-bust cycle, as Figure 2.3 below demonstrates.

Figure 2.3 ***The Production Tax Credit and its Impact on Wind Energy Installations***



Source: Union of Concerned Scientists and American Wind Energy Association

2.3 THE ROLE OF CLIMATE CHANGE AWARENESS

Over the past few years public awareness of, and concern about, global climate change has risen considerably. A Washington Post/ABC News/Stanford University poll conducted in April 2007, for example, shows that the proportion of the public that views global climate change as the single most important environmental issue facing the world today has more than doubled since a year ago to 33 percent (from 16 percent in 2006), and 70 percent feel the federal government should do more than it's currently doing to address the problem.[32] Similarly, a New York Times/CBS News poll from April 2007 found a sense of urgency in the public about this issue, as well as a willingness to make sacrifices to address it. The poll found 78 percent of respondents saying it's important to take steps "right away" to counter the effects of global warming, and 75 percent said they'd be willing to pay more for electricity generated by renewable sources in order to help reduce global warming.[33] With the U.N. Intergovernmental Panel on Climate Change (IPCC) report earlier this year saying that it was at least 90 percent certain that human activities had contributed significantly to the Earth's warming trend over the past 50 years, it would seem that the number of people who feel that climate change is a real problem and that governments need to take action to address it will only increase further.

On January 22, 2007 10 major U.S. companies in collaboration with four environmental groups called for swift action on global climate change.[34] The United States Climate Action Partnership (USCAP) has called for federal action on carbon regulations. They comment: *"In our view, the climate change challenge will create more economic opportunities than risks for the U.S. economy."*

In addition, the number of organizations focusing on going "carbon neutral" (from cities to radio stations to rock concerts to presidential campaigns) certainly serves as an indicator that concern over climate change has firmly taken root in the public at large. With venture capital's reputation as a creator of new industries and markets, perhaps it's not surprising that the cleantech industry (and the energy technology sub-sector in particular) has attracted an increasing amount of investor interest. In fact, in one of our open-ended survey questions, 30 percent of our respondents cited the growth in overall public awareness of the subject as a cleantech industry barrier that has been removed in the past few years.

Another explanation also exists for the sudden growth of the cleantech sector: companies around the world are realizing that reducing their environmental footprints can actually be good for business. For example, a recent study by McKinsey & Company in The McKinsey Quarterly estimates that six gigatons of carbon dioxide-equivalent emissions could be abated by 2030 (equivalent to reducing energy demand growth by half) through measures that have a zero or negative net life cycle cost![35] By improving building insulation and using more fuel-efficient vehicles, for examples, companies can save money, reduce their environmental impact, and receive a PR boost.

A 2006 survey of 150 companies in the U.S., U.K., France, and Germany by AMR Research found that the top environmental concern among the executives in the survey was "Energy and Emissions Reductions."[36] As companies are increasingly scrutinized on their stewardship of the environment, corporate social responsibility has become a key component of almost every company's business strategy – and a means of gaining a competitive advantage over others. Even without government regulations, energy use and greenhouse gas emissions have apparently risen to the top of the list of targeted activities.

One industry that is especially sensitive to issues of energy use and greenhouse gas emissions is the skiing and snowboarding industry. Facing mounting evidence that global climate change is already causing snow packs and glaciers to dwindle, this industry whose fortunes rely on having a significant base of snow for four to six months out of the year stands to be impacted far more severely than most. As a result, it's not taking any chances and not waiting for the federal government to lead the way. Temperatures in the western U.S. have already risen by 1.4 degrees since the 1950s,[37] and according to Pat O'Donnell, CEO of the Aspen Skiing Company, *"We began to realize that if our temperatures begin to rise just one degree it would be a disaster for us, because we could not make early snow that could carry us through the entire season."* [38] So several years ago, Aspen started to take action, leading a movement that has caught on throughout the skiing industry. They began to make energy efficient retrofits to their facilities, using biodiesel in their snowmobiles, installing solar panels, and lobbying lawmakers on climate change and renewable energy measures.[39] They've even begun purchasing wind energy credits to offset 100 percent of their electricity usage, something that more than 20 other ski resorts have now joined them in doing.[40]

Wal-Mart has become a visible example of the corporate world's recognition that attention to environmental issues can mean lower costs and greater market opportunities. The world's largest retailer, with a laser-like focus on its bottom-line, announced in 2006 its long-term goals of using 100 percent renewable energy at all of its stores, reducing the greenhouse gas emissions of those stores by 20 percent, creating zero waste, selling 100 million energy efficient compact fluorescent light bulbs (CFLs) per year, and investing $500 million per year in other energy initiatives.[41] The company is also planning a major move into the solar market, getting ready to install systems that could add up to 100 megawatts of power production within the next five years.[42] In addition to the symbolic importance of the world's largest retail store making these moves, Wal-Mart's aggressive environmental stance could also portend changes throughout industry as other businesses try to keep up.

CHAPTER 3

CLEANTECH'S IMPLICATIONS

3.1 THE GROWING PUBLIC MARKET FOR CLEANTECH

Until the last two years, there were very few examples of successful public offerings for cleantech companies. Since 2005 the cleantech industry has seen a series of large, high-profile IPOs, particularly in the biofuels and solar markets. After Sunpower and Suntech went public in late 2005, no fewer than seven photovoltaics companies (Canadian Solar, First Solar, PowerFilm, Akeena Solar, ReneSola, Trina Solar Limited, and Solarfun Power Holdings) went public last year, with another handful preparing for 2007 IPOs. Recent IPOs in the biofuels sector have included Aventine Renewable Energy, Pacific Ethanol, Verasun, and U.S. BioEnergy.

The shear number and size of these cleantech IPOs is significant for two major reasons. First and foremost, it provides the industry with a serious infusion of capital – exactly what it needs in order to expand and continue its robust growth. Secondly, these public offerings signal the creation of a healthy, well-defined cleantech market. The growing number of successful "exits" for venture capital investors over the last two years suggests that returns from cleantech investments are starting to be as attractive as returns from other investment categories, which in turn attracts more venture capital to the industry.

It also means that, as more cleantech companies successfully go public, the industry begins to look like a more attractive investment to the average investor in the public markets. Where it was once a cottage industry, cleantech is now widely accepted by businesses trying to become more efficient and is becoming a mainstream option for the average investor looking for a strong return. As we mentioned in Chapter 1, the Cleantech Capital Indices LLC Cleantech Index (CTIUS) has outperformed the S&P 500, the NASDAQ, and the Dow Jones Industrial average over the past two years.

3.2 THE ENGINE OF THE ECONOMY: JOBS

In addition to the creation of new companies and new market value there is another, more concrete reason policy makers should be interested in the cleantech boom: jobs. Cleantech has the potential to become a significant U.S. industry. According to a National Venture Capital Association/Global Insight 2007 report, venture-backed companies create more jobs, and

produce substantially more revenue than non-venture-backed companies. Based on an analysis of 23,500 venture-backed companies from 1970 to 2005, the report notes that in 2005 alone, venture-backed companies employed 10 million workers (9 percent of total U.S. private sector employment) and generated $2.1 trillion in revenue (16.6 percent of U.S. GDP). The report also finds that from 2003 to 2005, the rate of job growth at venture-backed companies was more than three times that at non-venture companies (4.1 percent vs. 1.3 percent), and that sales growth at venture companies was also stronger (11.3 percent growth vs. 8.5 percent growth).[43]

In addition, the NVCA/Global Insight report may underestimate the impact of the cleantech venture capital industry on the country's employment and economy. A recent study by Daniel Kammen, Kamal Kapadia, and Matthias Fripp at the University of California at Berkeley concluded that *"the renewable energy sector generates more jobs per megawatt of power installed, per unit of energy produced, and per dollar of investment, than the fossil fuel-based energy sector."*[44] Compared to traditional power sources like coal and gas-fired power plants, Kammen et al. found that the wind industry employs 2.8 times as many workers for the same power output. For solar photovoltaic power they estimate that seven to eleven times as many workers are employed.

> "The renewable energy sector generates more jobs per megawatt of power installed, per unit of energy produced, and per dollar of investment, than the fossil fuel-based energy sector."
>
> - Kammen, et. al. University of California, Berkeley

Another study by the Renewable Energy Policy Project drew similar conclusions: they found that for every megawatt of solar power installed, the industry creates 35.5 new jobs in manufacturing, installation, servicing, sales, and marketing.[45] So while traditional manufacturing jobs continue to move away from the U.S., the country now has an opportunity to become a global hub of new, high-quality jobs in manufacturing and other high-skill areas – while generating environmental benefits at the same time.

The studies discussed above demonstrate that venture capital invested in the cleantech industry may create more new jobs and revenue than the amounts projected in the NVCA/Global Insight report for venture capital as a whole. To correlate venture investment and jobs, our 2004 report[46] used 30 years of data from the NVCA to project how many jobs the cleantech industry could create in coming years. This report found that, as a general rule of thumb, every $100 million in venture capital investments can generate 2,700 new jobs at the venture-backed companies and an additional $500 million in new revenue directly from those firms (as well as an unknown amount of indirect job and revenue creation).

Using historical data on cleantech venture capital investments in North America from 2001 to 2006 along with the above rule of thumb, it is possible to derive order-of-magnitude estimates of the potential new jobs and revenue that the industry might bring in. To do so we must first make assumptions about the rate of growth of venture investments in North America several years into the future. For the period 2001 to 2006, the average annual growth rate of cleantech investments, adjusted for inflation, was a robust 27.5 percent. Even if we assume a more modest growth rate of 10-20 percent, North American cleantech start-ups would be in line to receive between $14 billion and $19 billion in venture financing between 2007 and 2010.

Based on the simple rule of thumb described above, these investments could lead to the creation of between 400,000 and 500,000 new high-paying, high-quality jobs, and new revenue streams of $70 billion to $95 billion.[47] Between 2005 and 2006 U.S. cleantech investments grew by over 80 percent.

3.3 THE SIZE OF THE CLEANTECH MARKET

By looking at the historical record of an industry's venture capital investments and making assumptions about the amount of follow-on financing companies are likely to receive and the growth rate of financing for new projects, one can estimate the total size of the cleantech market in the future. A 2006 Cleantech Venture Network report followed this methodology to project the growth of the North American cleantech market from 2006 to 2009, using its history of venture investments from 1999 to 2005.[48] It assumed that companies receiving a first round of financing (Series A) would receive two follow-on rounds – two years and then three years after the first round – with both rounds being 60 percent larger than the first. It also assumed that the companies would have a 60 percent survival rate at each round – i.e. 40 percent of the companies would fail to make it to the next round.

With three different assumptions about the rate of new financing growth (from 11 percent to 32 percent annual growth), this model came up with three possible trajectories for the industry over the next few years. The most cautious scenario, which assumed that the annual growth rate of financing (11 percent) would be half of its historical level from 1999 to 2005, shows cleantech venture capital reaching a total of $6.1 billion in financing from 2006 - 2009 on 1,030 venture deals. The most optimistic scenario modeled shows cleantech venture capital reaching a total of $8.8 billion on 1,466 deals between 2006 and 2009.

However, given the growth the market saw last year, it now looks as though the projections made in this 2006 Cleantech Venture Network report were far too conservative. In fact, North American cleantech investments for 2006 ($2.9 billion) actually exceeded the 2008 investment total predicted by the most aggressive scenario in that report. These scenarios also projected that at their strongest rate of growth, cleantech would eventually account for up to 10 percent of all venture capital investments by 2009. However, as we've seen already, cleantech deals already accounted for 11 percent of all North American venture capital last year. While it's unlikely that the industry will continue to see annual growth in the 80 percent range like that of 2006, given all of the industry drivers described above, cleantech could continue to expand and command larger shares of all investment sums.

The Cleantech Venture Network's most recent projections reflect this new reality. They now estimate that the North American cleantech industry will grow at a 25% annual rate from its 2006 investment total of $2.9 billion over the next four years, bringing in a sum of $16.6 billion in venture capital for the 2006-2009 period.[49] We should note that this investment total is right in line with our own independent projection of $14 billion to $19 billion in new investments for the 2007 to 2010 period, as described in section 3.2.

3.4 ANCILLARY BENEFITS OF CLEANTECH

The classic argument against environmental legislation is that the economy (and the state's or nation's competitiveness) will be harmed as a result, suffering job losses and negative growth. However, the track record of the cleantech industry to date belies this logic. As the cleantech space has grown since 2001, jobs have been created not only in the companies that have been conceived during that time, but also in many ancillary industries (law, accounting, banking, consulting, and public relations to name a few) and even in the public sector. In California, for example, the state's recently passed greenhouse gas legislation (AB 32) and augmented renewable portfolio standard are projected to increase the state's economic output.[50]

Similarly, private entities that must comply with such laws have beefed up their spending on R&D both in-house and at state universities. The most significant example of this phenomenon is the recent announcement by BP of a $500 million grant to the University of California and the University of Illinois to pursue biofuels research.[51] The bottom line appears to be that well thought out environmental regulations will not harm U.S. businesses, but simply change the way the U.S. does business.

> "Some have challenged whether AB32 is good for businesses. I say unquestionably it is good for businesses. Not only large, well-established businesses, but small businesses that will harness their entrepreneurial spirit to help us achieve our climate goals."
>
> -Arnold Schwarzenegger, Governor, California

California has recognized this. After signing the landmark Global Warming Solutions Act of 2006 last September, California Governor Arnold Schwarzenegger said, *"Some have challenged whether AB32 is good for businesses. I say unquestionably it is good for businesses. Not only large, well-established businesses, but small businesses that will harness their entrepreneurial spirit to help us achieve our climate goals."*[52] This opinion appears to be backed up by most serious economic studies of the law.[53] Indeed, a recent report for the British government by the former Chief Economist at the World Bank ("the Stern Review on the Economics of Climate Change") estimated that the cost of *not* taking serious action to mitigate the effects of climate change could result in an annual loss of 5 to 20 percent of global GDP. And on the flip side, the report projected that the cost of the actions necessary to avoid climate change would amount to only 1 percent of global GDP per year.[54]

In fact, as this report shows, California's proactive environmental stance has probably contributed significantly to it becoming a major hub of the cleantech industry. Many major corporations in the U.S. have recognized this as well – and are taking advantage of it. Companies like General Electric, Duke Energy, and Wal-Mart have come to realize that not only are major new environmental regulations (such as a mandatory national carbon cap) likely on the way in the next few years, but that they have an opportunity to capitalize on this new business climate by planning ahead for this event.

CHAPTER 4

PUBLIC POLICY OPTIONS

The past few years have seen states and local governments implementing a variety of innovative and important new policies relating to the cleantech industry. In keeping with their track record of public policy innovation, some states – including California, Colorado, Connecticut, Iowa, New York, South Carolina, and Wisconsin, whose actions we detail in this section – are taking the lead in demonstrating the benefits of policies and programs that could serve as models for other states, or the country as a whole. Although these policies are numerous and diverse, they generally fall into three different categories according to their designed objective. The three categories of objectives are:

1. Building demand (directly or indirectly) for cleantech products or services
2. Providing extra financial backing (directly or indirectly) to cleantech companies
3. Providing business development assistance or other indirect assistance to cleantech companies

4.1 BUILDING DEMAND FOR CLEANTECH PRODUCTS – DIRECTLY

Federal, state, and local governments spend many trillions of dollars each year. According to the Congressional Budget Office, federal government outlays alone make up roughly 20 percent of the size of the U.S. economy.[55] America's federal government is likely the world's largest consumer of goods and services, spending $200 billion per year directly and an additional $240 billion per year indirectly through grant disbursements.[56] Initiatives that encourage, or require, governments to be model consumers and purchase environmentally-friendly goods and services can significantly boost the cleantech market. While governments have been taking steps to becoming bigger, better cleantech customers for some time now, they have certainly picked up the pace recently. Examples include:

- *Iowa* – In 2005 Governor Tom Vilsack issued an executive order requiring state agencies to increase their use of renewable energy and improve their energy efficiency. The order called for a 15 percent energy efficiency improvement at state facilities by 2010, a minimum of 10 percent of electricity being procured from renewable sources, as well as an increase in the procurement of alternative fuel vehicles.[57]

- *Wisconsin* – Governor Jim Doyle signed an executive order in April 2006 mandating that all state government buildings (existing buildings and those to be constructed in the future) conform to U.S. Green Building Council LEED standards. The order requires state agency buildings to reduce their overall energy consumption by 20 percent by 2010, and it anticipates that the LEED standards will enable it to reduce energy use by up to 30 percent.[58]

- *U.S. Environmental Protection Agency* – Fittingly, as the federal agency whose tasks include regulating the quality of the air we breathe and the water we drink, the EPA is now using renewable energy (including solar, wind, geothermal, and fuel cells) generated onsite at its facilities in nine states.[59]

- *Environmentally Preferable Purchasing Programs* – These programs, which are designed to reduce waste, pollution, and use of toxic or non-recyclable products, have become quite popular lately, and are now in place at the federal level, and in a number of states and cities, including California, Delaware, Massachusetts, Michigan, Missouri, Minnesota, New Jersey, North Carolina, Ohio, Vermont, Wisconsin, San Francisco, Seattle, Alameda County in California, and King County in Washington.[60]

- *Iowa* – In 2005 Governor Tom Vilsack issued an executive order requiring state agencies to increase their use of renewable energy and improve their energy efficiency. The order called for a 15% energy efficiency improvement at state facilities by 2010, a minimum of 10% of electricity being procured from renewable sources, as well as an increase in the procurement of alternative fuel vehicles.[61]

- *Wisconsin* – Governor Jim Doyle signed an executive order in April 2006 mandating that all state government buildings (existing buildings and those to be constructed in the future) conform to U.S. Green Building Council LEED standards. The order requires state agency buildings to reduce their overall energy consumption by 20% by 2010, and it anticipates that the LEED standards will enable them to reduce energy use by up to 30%.[62]

4.2 BUILDING DEMAND FOR CLEANTECH PRODUCTS – INDIRECTLY

Policies with the highest leverage are aimed at indirectly encouraging consumers to make cleantech purchases. Some of these take the form of subsidies and incentives for cleantech products, or taxes on non-cleantech products. Another popular form of indirect incentives employs regulations which require consumers to purchase a fixed amount or percentage of cleantech products – as in an RPS or RFS. Finally, there are certain measures, like the RGGI or California's Global Warming Solutions Act (AB32), which will create new cleantech markets from scratch through innovative economic regulations. Although there are a plethora of state and city level programs around the country designed to indirectly drive demand for cleantech products – renewable portfolio standards, production tax credits, etc. – what follows is a brief sampling of some of the recent important policy advances in this area:

- *The California Global Warming Solutions Act of 2006 (AB32)* – This landmark climate legislation was signed into law in September 2006, establishing the first

mandatory statewide comprehensive regulatory program to reduce greenhouse gas emissions that includes penalties for non-compliance. This historic measure requires California, through a combination of mandatory caps on emission combined with market-based mechanisms, to reduce its emissions to 1990 levels by 2020 (a 30 percent reduction from business-as-usual projections). The law requires the state's Air Resources Board (ARB) track statewide greenhouse gas emissions as it simultaneously establishes regulatory mechanisms to enforce emissions targets (such as a load-based cap-and-trade system). Beginning in 2012, emissions reduction requirements will take effect for the state's largest sources, which the ARB will continue to monitor and gradually ratchet down over time.[63]

AB32 has tremendous implications worldwide. Everyone will be watching to see how successful California – the 12th largest greenhouse gas emitter in the world, and the seventh largest economy – will be in reducing its climate change impacts while maintaining a healthy level of economic growth. Much is at stake for the cleantech industry, as well. Given the size of the state and its economy, it is inevitable that businesses will continue to operate in California. The establishment of these mandatory emissions reductions, then, makes it a certainty that a tremendous market will exist well into the future for goods and services that help companies meet their greenhouse gas caps in an efficient manner. According to Lexi Schultz of the Union of Concerned Scientists, an emissions cap "will spur technological innovation" as companies race to reduce their emissions in order to sell the credits for those emissions that they no longer need on the market.[64]

- *California's Greenhouse Gases Emission Performance Standard Act (SB1368)* – At about the same time California lawmakers were passing AB32, they were also working to ensure that the electricity used in the state would be clean and low-carbon well into the future. SB1368, which became law last September, directs the California Energy Commission to set greenhouse gas emissions standards for the baseload electricity used by the state (whether generated in-state or imported from out of state).[65] The law effectively prevents the state from signing any long-term procurement contracts for traditional coal-fired power, or any electricity that comes from sources that emit more than a clean, efficient natural gas power plant. (However, the law doesn't explicitly ban any particular form of energy generation – electricity from coal plants with carbon sequestration, for example, would still be able to be sold in the state.)

  While almost no electricity from coal is currently generated in California, the state still imports a fair amount of coal-generated power from outside its borders – and at last count, dozens of new coal power plants were being planned for construction in western states, many with the aim of selling their power in the growing California electricity market. But SB1368 sends a strong signal to western energy markets, aiming to discourage these large, long-term investments in highly polluting technologies. As a result, cleaner production technologies, like geothermal, wind, or small hydro, will receive a significant competitive advantage in the state.

- *The California Solar Initiative (CSI)* – This program, which had languished in the state legislature for years, finally became a reality in 2006. The $3.3 billion program

provides incentives to customers to offset the cost of installing a solar photovoltaic system, with the goal of enabling the state to put 3,000 megawatts of new, distributed solar power online by 2017 and bringing the cost of photovoltaic power down to the point where it is competitive with conventional power sources. The huge program, which is the second largest solar incentive program in the world, provides direct incentives to consumers that start at $2.50 per watt of installed capacity and decline by roughly 10 percent per year – in order to put pressure on the industry to bring costs down and prevent the subsidies from artificially inflating the purchase price of the solar systems. Another key feature of the CSI is that the incentives are based on the expected performance of the system customers install, not simply its nameplate capacity. This means that a system installed in a sunny, shade-free area might receive the maximum incentive, while one installed in an area with lower solar potential would not. This feature ensures that CSI subsidies maximize the actual amount of new energy production, not simply the number of new system installations.[66]

- *The California Low Carbon Fuel Standard (LCFS)* – In January 2007, Governor Arnold Schwarzenegger signed an executive order establishing the world's first LCFS. This initiative will require that all transportation fuel sold in California meets a declining standard for greenhouse gas emissions (measured in carbon dioxide-equivalent gram per unit of fuel energy sold). By 2020 the LCFS is designed to reduce California's transportation related greenhouse gas emissions by 10 percent – the equivalent of taking three million cars off the road.[67] Although the program sets a target for emissions reductions, it does not mandate a particular path that fuel providers take to reach it, allowing for a market-based approach that will minimize the cost of meeting the standard. For example, providers could meet the requirements by increasing the amount of sustainably-produced ethanol added to the gasoline they sell, purchasing carbon credits from electric utilities, or diversifying their fuel supply to include hydrogen. The LCFS, which is expected to reduce emissions by 13 million metric tons by 2020, has an added benefit: economists predict that it could triple the size of the state's biofuels market, giving an added boost to a sector that already had an incredible year in 2006.[68]

- *Emissions Credit Trading* – After the leadership of northeastern states initiating emissions credit trading in 2005 (RGGI), west coast states launched similar efforts in 2006 and 2007. Last October, California Governor Arnold Schwarzenegger and New York Governor George Pataki announced plans to link emissions trading between the carbon markets being developed in California (to meet the state's Global Warming Solutions Act goals) and the markets of the northeastern states participating in the Regional Greenhouse Gas Initiative (RGGI).[69] Four months later, the governors of California, New Mexico, Arizona, Oregon, and Washington added to the momentum behind emissions credit trading. The five states signed an agreement establishing the Western Regional Climate Action Initiative (WRCAI), the objective of which is to reduce greenhouse gas emissions and the effects of climate change.

  Similar in structure to RGGI, the WRCAI will involve the coordination of the respective states' Public Utilities Commissions, which will first establish a regional emissions target and then set up a market-based program (such as a cap-and-trade system) to allow the region to meet its emissions goals. The initiative also sets up a

registry program to track and record emissions levels.[70] While all five states currently have their own separate emissions reduction goals, the WRCAI will better enable them all to coordinate efforts, share information, and achieve emissions reductions in the most economically efficient manner. And by linking their markets, California, the west coast states, and the RGGI states of the northeast not only improve the efficiency with which they can meet their goals, they also build up a critical mass behind emissions credit trading in the U.S., laying the groundwork for a nationwide system.

- *Washington, D.C.* – In 2006 the District of Columbia Council voted to become the first big city to require that all new development – private buildings as well as government buildings – adhere to U.S. Green Building Council LEED standards as well as Energy Star standards. The law, the District of Columbia Green Building Law of 2006, will be phased in over time, applying only to government buildings in 2007, but by 2012 requiring that all new construction meet the green building standards.[71]

- *Colorado* – In November 2006, voters in Boulder became the first in the country to institute a direct and self-imposed tax in order to reduce their global warming emissions. The Climate Action Plan Tax – which is expected to raise the average household's monthly electric bill by $1.33 – applies to all electricity generated from fossil fuel-fired power plants. The revenue generated by the tax – projected to be about $1 million per year – will be used by the City to invest in renewable energy, energy efficiency, and clean transportation in order to meet its goal of reducing its greenhouse gas emissions 7 percent below 1990 levels by 2012.[72]

- *Connecticut* – Starting in 2007 the Act Concerning Clean Cars is set to require auto manufacturers to place a clearly visible label displaying the vehicle's greenhouse gas emissions on all vehicles sold in the state, as well as how those emissions compare to all other vehicles sold that year. The program, to be funded by a $5 fee on new vehicle registrations, is aimed at providing consumers with the information they need to become more critical, discerning cleantech customers. The law will also have teeth: beginning with the 2009 model year, vehicles without the emissions label will be barred from being sold or leased in the state.[73]

- *New York* – Addressing growing energy consumption, New York became the latest in a series of states imposing energy efficiency standards on a variety of household appliances not covered by federal regulations.[d] The Appliance and Equipment Energy Efficiency Standards Act of 2005, which will allow the state to set energy efficiency standards for ceiling fans, washing machines, commercial refrigerators and freezers, and torchiere lighting fixtures, is expected save enough energy to power 350,000 homes. It's also expected to benefit consumers, saving them almost $300 million per year in energy costs, and the environment, reducing carbon dioxide emissions by 870,000 metric tons. The Act also allows the state to develop energy efficiency standards to reduce "phantom" energy use by DVD players, VCRs, and digital television adapters, which often draw power even when the device is turned off.[74]

[d] Arizona, California, Connecticut, Maryland, and New Jersey have also adopted similar advanced energy efficiency standards.

- *South Carolina* – In 2006 South Carolina joined a growing list of states and localities offering customers special perks to encourage them to buy cleaner vehicles.[e] While many parts of the country allow vehicles with low emissions or high gas mileage to drive in high occupancy vehicle lanes, South Carolina's approach is to provide a state income tax credit (equal to 20 percent of the size of the federal tax credit) to individuals purchasing clean vehicles, defined as new hybrid, fuel cell, alternative fuel, or lean burn technology vehicles.[75] The state also recently approved an ethanol and biodiesel production tax credit, providing a 20 cent per gallon credit during the first 5 years of production for projects initiated between 2007 and 2009. That piece of legislation also awards tax credits for the installation of solar heating and cooling systems, and landfill gas systems.[76]

4.3 PROVIDING EXTRA FINANCIAL BACKING TO CLEANTECH COMPANIES

In addition to increasing demand for already existing cleantech products and services, policymakers can play an important role in stimulating cleantech companies to bring their goods to the marketplace more quickly and successfully. A typical product development cycle begins with entrepreneurs coming up with a product idea and beginning a period of intensive research and development (R&D) and testing – often funded by government basic R&D grants. But as the product becomes more refined it moves from this initial phase into the demonstration and deployment phases.

At this point in the cycle products are typically still several years away from commercialization, as the entrepreneurs must work on business plan development, demonstrating the product on a large scale, and market preparation. In this phase costs are typically high – particularly for energy-related technologies - but financing can be difficult to acquire because products are usually still a few years away from revenue generation.

Even venture capitalists often shy away from companies in this phase of the cycle due to the high level of risk and the long timeframe until profitability. Consequently, many businesses fail in this phase, which is commonly referred to as the financing "Valley of Death". By bridging this financing gap between basic R&D financing and venture capital financing, government can improve the success rates of new startups and significantly shorten the product development cycle. A few of the new initiatives aimed at accomplishing this feat are outlined below:

- *The Solar America Initiative (SAI)* – To restore the U.S. to its position as a world leader in solar power, the Department of Energy recently initiated the $148 million SAI program. Similar to the CSI, the SAI's goal is to make solar power cost-competitive with other forms of power generation by 2015. The SAI's competitive grant-making process awards funding to product developers in four different areas: market transformation (activities targeting market expansion and barriers), proof of concept work, prototyping and pilot-scale production, and system development and manufacturing.[77] Thus SAI funds are directed both toward companies in the earliest

[e] Colorado, Connecticut, the District of Columbia, Illinois, Louisiana, Maine, New Mexico, New York, Oregon, Pennsylvania, and Utah are among the other states offering preferential tax treatment to purchasers of clean vehicles.

phases of development (proof of concept), but also at companies that have moved past that stage and require significant funds for demonstration and deployment work.

- *The California Solar Initiative's Research Development & Demonstration (RD&D) Fund* – A small component of the larger $3.2 billion CSI program, the RD&D fund is a $50 million, ten year venture whose purpose is similar to that of the SAI: to provide additional seed financing to entrepreneurs to help them overcome market barriers and commercialize their products. (Its overall goals are also the same as the CSI as a whole: to develop a competitive, self-sustaining solar industry, and to install 3,000 new megawatts of solar power in the state by 2017.) The fund aims to coordinate efforts with the DOE's SAI program, as well as with the California Energy Commission's Public Interest Energy Research (PIER) program to avoid duplicating their efforts and to focus on critical gaps in funding that still exist.[78]

- *The California Clean Energy Fund (CalCEF)* – One of a number of relatively new state-level "public benefit" funds designed to provide early-stage cleantech companies with seed financing, CalCEF is a $30 million fund created in 2004 as part of the Pacific Gas & Electric (PG&E) Company's bankruptcy settlement. The fund's aim is to invest in companies whose products have the potential to benefit ratepayers in PG&E's service area and beyond. While the fund itself is a non-profit entity, it makes for-profit investment in its companies, with the profits from these investments reinvested in the fund. CalCEF has also formed a partnership with three prominent cleantech venture capital firms – Nth Power, Draper Fisher Jurvetson, and VantagePoint Venture Partners – which will each manage a portion of the fund and match the CalCEF investments up to $10 for every CalCEF $1 with their own funding, helping to stretch the original $30 million pot of money significantly further.[79] The fund has recently started a program for seed funding.[11]

- *Business Competitions and Prizes* – While many business plan competitions exist (MIT's $100K Entrepreneurship Competition may be the best-known example), the California Clean Tech Open is unique in that it is open to anyone – students and professionals alike – and is restricted entirely to cleantech innovations. In addition to providing a large amount of prize money to the winners in six different categories, the competition provides the winners with a full "start-up in a box package" that also includes office space and in-kind services (e.g. legal, PR, and accounting services). Last year these prizes were valued at over $600,000 altogether. And the winners aren't the only ones who benefit: all of the finalists (up to 50 teams) receive classes and mentoring from experienced entrepreneurs, venture capitalists, and technology experts to help them improve their companies and products. All with the goal of accelerating "the transformation of great ideas into thriving businesses that will turn California into a clean technology powerhouse and enrich the state's other industries."[80] Other entrepreneurial competitions (such as the $10 million Automotive X PRIZE, which aims to develop a production capable car that can get 100 miles per gallon, or Richard Branson's $25 million global warming prize) have the same overall objective – spurring innovation – but require a fully demonstrated product, rather than a business plan.

- *Public-Private Venture Funds* – The California Clean Energy Fund and the Massachusetts Green Energy Fund are two examples of new state-level public-private venture funds focusing on the cleantech space.[81] The idea behind them is that because cleantech products can benefit a state's environment and economy, the state should play a role in helping to bridge the early-stage funding gap that exists for many start-ups that are operating in the "Valley of Death." While somewhat modest in size, the two funds provide models for what other states or even the federal government could do in this area. In fact, the U.S. government has already pioneered the use of public-private venture financing: it operates such funds through the Central Intelligence Agency (In-Q-Tel), the Army (OnPoint Technologies), and the National Aeronautics and Space Administration (Red Planet Capital) – all of which are regarded as success stories.[82]

4.4 PROVIDING BUSINESS DEVELOPMENT ASSISTANCE AND OTHER INDIRECT ASSISTANCE TO CLEANTECH COMPANIES

The public sector has a variety of other tools at its disposal to boost the cleantech industry, in addition to the highly visible strategies described above. The following are examples of measures that can be taken that may not even seem to be directly related to the cleantech space, but which nonetheless will improve the competitiveness of cleantech companies, benefit the environment, and strengthen a region's economy:

- *Inter-regional Cooperative Agreements* – Particular states and regions often develop special capabilities in a particular industry or field, and many times this knowledge and experience can be shared or exchanged with others to the benefit of all. Last June, for example, the California Energy Commission and Sweden's Ministry of the Environment signed a joint development agreement for biogas and other alternative fuels. The agreement will promote the exchange of ideas and technologies between the two, enabling California to learn from Sweden's biogas experience (the country has the largest biogas vehicle fleet in the world), while providing Sweden with an opportunity to market its products in California markets.[83] President Bush and Brazilian President Luiz Inacio Lula da Silva recently signed a similar agreement regarding ethanol that will promote technology exchange between the countries and work to develop international biofuels standards.[84]

- *Public Education Investment* – One of the major reasons commonly cited for the emergence of California's Silicon Valley as a major hub of the cleantech industry is the presence there of two major universities – U.C. Berkeley and Stanford – with world-class scientific research programs and top business schools. These two institutions graduate a pool of first-class technical researchers and business-savvy students, many of whom become entrepreneurs. While investing in public education will benefit a great number of industries, it will certainly have a strong impact on the cleantech industry – particularly if it's directed towards improving scientific skills in areas like biology, chemistry, physics, engineering, environmental science, and mathematics. Such investments will have a large (albeit long-term) payoff too – they will no doubt yield more highly skilled workers, more innovation, and greater tax revenue. Just as importantly, education investments will ensure that the cleantech

industry will remain a fixture in this country, rather than relocating to a region with highly skilled, cheaper labor.

- *Cleantech Incubators and Business Assistance* – Like the business plan competitions described above, incubators help young companies develop the business skills and acumen critical to becoming commercially successful. Typical incubators enable their companies to share office space, basic business services, technical support, and equipment in order to save costs. They also generally offer management advice, technical assistance, networking opportunities, consulting services, and assistance obtaining financing. Incubators can be targeted to specific industries, like cleantech, or open to a broader range of companies, but whatever their form, they are likely to improve the survival rate of new start-ups and speed the product development and commercialization process. Austin's Clean Energy Incubator – a joint program between the Austin Technology Incubator, the National Renewable Energy Laboratory, the Texas State Energy Conservation Office, and Austin Energy – is an excellent example of how this strategy can be applied specifically to the cleantech industry. The Clean Energy Incubator has access to The University of Texas and its research capabilities and the Austin Energy as its testbed partner. These close working relationships provide accelerated validation of new energy technologies in a real world operating environment meeting the climate change targets of the City of Austin.

> "If the federal policy is unclear or inconsistent, it introduces an element of risk that detracts from the attractiveness of a potential investment. If a federal policy is supportive and appears stable, it makes the investment more attractive."

- *Public Leadership* – The voice of the public – whether in office or as a citizen – is a powerful tool – and one that can be put to use to promote the cleantech industry. Over the past few years, a variety of public and private citizens – Vice President Al Gore, Governor Arnold Schwarzenegger, Richard Branson, even Leonardo DiCaprio – have all used their public prominence to raise awareness about global climate change. By voicing their backing for the cleantech industry, public leaders can continue to raise awareness on the subject, send a message to cleantech companies that they will receive strong public support in that area, and even signal to the federal government that this industry is one that should be strongly supported. This sort of public cheerleading and encouragement can play a role not only in giving a particular U.S. region a leg up on others in the battle for cleantech investment dollars and revenue, but also in preventing these companies from being wooed away to other countries.

4.5 REMAINING BARRIERS TO CLEANTECH

Over the past few years, the atmosphere in which the cleantech industry operates has improved significantly. Venture investments, public support, the political and regulatory environment, and technological innovation have all begun to converge, to the benefit of the industry and the public. But it could be even better. In spite of the many steps that have been taken in support of the cleantech industry, barriers still remain, keeping it from growing even bigger and faster. The

most common barriers are inconsistent policy, long term subsidies for conventional industries, and trade barriers.

Among the investors we surveyed, the most often cited complaint about the current regulatory environment surrounding cleantech was the inconsistency and unpredictability of policies affecting the industry. In an open-ended question about industry barriers, 37 percent of our survey respondents volunteered their strong desire for a long-term, predictable approach to policymaking in this arena. As one investor noted, *"If the federal policy is unclear or inconsistent, it introduces an element of risk that detracts from the attractiveness of a potential investment. If a federal policy is supportive and appears stable, it makes the investment more attractive."* It appeared to be the group consensus that a less than perfect – but predictable – policy would be preferred over a better policy that comes and goes and can't be relied on.

Another barrier that investors mentioned regularly in the survey (27 percent of the investors surveyed discussed it) is the fact that cleantech products aren't playing on a level playing field with traditional alternatives. These respondents believe that conventional technologies (e.g. fossil fuels) regularly receive large government subsidies that give them a price advantage, even though these technologies have been mainstream for decades. (According to the U.S. Government Accountability Office, the petroleum industry alone received as much as $150 billion in tax incentives between 1968 and 2000.[85]) One investor suggested that *"corporate welfare for larger companies provides a hidden subsidy to non-cleantech companies. Provide equal subsidies for all technologies, or provide none. Let market forces decide the best application of innovation."*

While the relatively modest subsidies and incentives that the cleantech industry receives always receive intense scrutiny, the large, long-term subsidies that conventional industries are given are more often taken for granted. Investors were not, however, arguing for large incentives to prop up the industry. As Bill Reichert, Managing Director of Garage Technology Ventures said, *"The investment has to make sense independent of the public policy or the subsidy or the environmental fad of the month."*[86]

"Corporate welfare for larger companies provides a hidden subsidy to non-cleantech companies. Provide equal subsidies for all technologies, or provide none. Let market forces decide the best application of innovation."

There are other barriers to greater cleantech industry success. Investors cited trade barriers (e.g. tariffs on cleantech product imports), as well as a need to harmonize and simplify federal and state policies related to cleantech. Other factors slowing down the cleantech industry are for the most part of a technical nature – the need for cheaper, more efficient production of cellulosic ethanol and photovoltaic panels, or smaller and cheaper energy storage systems, for example.

There are also a number of problems of a financial or regulatory nature that need to be overcome. One illustrative example of this issue is the solar power industry. Economists, energy experts, and policymakers can all agree that homeowners installing photovoltaic systems are helping the environment and also likely saving themselves money in the long-run through their reduced energy bills. The large up-front costs of such systems, combined with the challenges of getting them installed and integrated into the electric grid discourage many potential consumers. Several new financial companies have entered the market to simplify the financing and installation of solar. These

include SunEdison, MMA Renewable Ventures, and New Resource Bank. This is an industry that could expand dramatically if new companies continue to reduce the financial risk to homeowners of installing them (e.g. third-party ownership or new mortgage and insurance policies) and to allow them to be more easily integrated with other systems (e.g. clear and uniform installation and interconnect standards, improved metering infrastructure, and better acceptance by utilities). For cleantech products to become fully integrated into everyday American life, the business and political communities will need to develop new models tailored specifically to the industry, recognizing that it is in some ways a completely different creature than traditional industries.

CHAPTER 5

RECOMMENDATIONS

The preceding sections of this paper have described where the cleantech industry is now and the many policies in place throughout the country that support it. In this section we will present our recommendations for what *should* be done at the Federal level to improve both the environment and the fortunes of cleantech companies in the future.

As the investors in our survey noted, cleantech products are frequently at a competitive disadvantage compared to conventional products. In addition to receiving significant subsidies, conventional products generally waste more natural resources and emit more pollution than cleantech products, thus imposing a cost on society that is not reflected in their price tags. In order to help level the playing field the prices of products need to better reflect their true economic costs to society, thereby sending a signal to consumers about the real effects of their choices.

- *Mandatory National Carbon Cap*

A mandatory, comprehensive national cap on greenhouse gas emissions, coupled with an emissions trading market, would immediately place a value on the release of carbon dioxide and other greenhouse gases, rewarding those companies that already operate in a clean and efficient manner, and forcing those companies that do not to improve their performances. More importantly, any changes that industry would make to reduce its environmental footprint and come into compliance with the cap would be done efficiently. By establishing an economy-wide cap on greenhouse gases – without specifying specific technologies or strategies – the market would naturally find the most cost-effective responses, whether by purchasing emissions credits, becoming more efficient, or altering the materials or processes used. Thus it should come as no surprise that 59 percent of respondents in our survey (17 of 29) said a national mandatory cap-and-trade system would be critical or important in influencing their investment decisions.

When ten major U.S. corporations[f] joined forces with four environmental advocacy groups in January to form the U.S. Climate Action Partnership (USCAP) and called on Congress to quickly pass legislation to tackle global climate change, it became clear that a significant, growing portion of U.S. businesses believe a carbon cap is necessary for U.S. competitiveness. USCAP, whose corporate members have a combined market capitalization of over $850 billion and whose non-profit groups have well over one million members worldwide, specifically called

[f] This group has since been joined by ConocoPhilips, the third largest U.S. oil company and second largest U.S. oil refiner, with a market capitalization of $116 billion.

for a mandatory cap-and-trade program, along with an accelerated technology research, development and demonstration program, and diplomatic efforts to convince other countries to follow suit.[87]

The unprecedented action of business leaders, including those from the utility industry, proactively and voluntarily seeking government regulation has been repeated several times since the January 2007 press conference. In March 2007, under the leadership of CERES, more than 50 major institutional investors with combined funds under management exceeding $4 trillion signed a statement asking Congress to impose clear, consistent climate change regulations to help them mitigate climate change risks. Because in addition to making them more competitive globally, a national carbon standard would allow American companies to avoid having to navigate a chaotic maze of state-by-state climate policies. *"Without national policies, the competitiveness of American business will be compromised. We don't think we can wait,"* said Fred Buenrostro, Jr., CEO of CalPERS, the country's largest public pension fund.[88]

> "Without national policies, the competitiveness of American business will be compromised. We don't think we can wait."
>
> -Fred Buenrostro, Jr.
> CEO of CalPERS

One week prior to the March 2007 CERES announcement, a bipartisan group of Silicon Valley venture capitalists and entrepreneurs testified in Congress about the need for greater federal tax incentives and research funding in cleantech. With a sense of urgency, they also recommended consolidating all federal energy research into a National Institute of Energy that could support public-private partnerships, in the model of the medical sciences' National Institute of Health. *"We are in a crisis, and we have to translate this crisis into opportunity. Missing this moment would be horrible,"* said Aart de Geus, CEO of Synopsys, an electronic design automation company.[89] These business leaders are also part of a bipartisan group of dozens of technology company CEOs known as TechNet, which also advocates establishing a national renewable portfolio standard, a national renewable energy credit marketplace, and a system of long-term, declining incentives for clean technologies.[90]

- *National Renewable Energy Standard*

California's experience over the past few decades demonstrates that, far from hurting an economy, well-designed cleantech regulations – such as California's advanced energy efficiency and air quality regulations – can actually stimulate innovation, leading to new economic growth. Knowing that, it becomes clear why 65 percent of the investors we surveyed (19 of 29) said a national renewable energy standard would be a critical or important factor in their investment decisions. In the increasingly carbon-constrained world in which we live, improving the performance of our renewable energy technologies through innovation will be extremely important – not only for our environment but for our economic competitiveness as well. A national renewable energy standard could be a major contributor in driving this innovation in next-generation clean energy technologies.

> "We are in a crisis, and we have to translate this crisis into opportunity. Missing this moment would be horrible."
>
> -Aart de Geus
> CEO of Synopsys

- *More Public R&D Investment*

While growth of the clean technologies would benefit from programs that increase demand (for example a cap-and-trade system or renewable portfolio standard), the industry still needs strong investment in basic R&D. Since the energy crises of the 1970s, federal spending on energy research is down significantly, with private investments making up some, but not all, of the difference. Fortunately for the cleantech industry, public and private investments in complementary industries such as biotechnology, semiconductors, and software have been quite strong in recent years, and there is a high degree of technical knowledge spillover from these industries to cleantech sectors. In fact, some of the same people who were involved in startup companies in those other industries in the 1990s are now getting involved in ethanol and photovoltaics companies, among others.[91]

Still, the success of the cleantech industry should not depend on spillover from its cousin industries, or from private investment alone. Public investment in cleantech research is also crucial, for several reasons:

- In its magnitude alone, it can accelerate the pace of research innovation and development.
- It helps to reassure private investors that this area is important to the public, is worth investing in, and will receive real public support. As one investor in our survey said, public support from individual states *"sends a message to entrepreneurs, investors and others that the state intends to create a business environment that is supportive of cleantech."*

Support from individual states "sends a message to entrepreneurs, investors and others that the state intends to create a business environment that is supportive of cleantech."

Public investment in basic R&D is still necessary to growing new industries of the future. The investors participating in our survey noted that a cleantech product must be able to stand on its own merits, and while they would not invest in a company solely on the basis of government support or subsidies, many noted that government investments are important and would encourage a higher level of private investing. For instance, 59 percent of respondents (17 of 29) said that a government program that matched private investment dollars would be critical or important to their investment decisions. One investor even noted that his fund's specific investing strategy is to *"leverage publicly funded research at labs and universities, so greater investment on the federal level in that research would be beneficial, as long as it is focused on commercial outcomes."*

- *The Importance of Implementation*

Aside from the policies themselves, the manner in which they are implemented is crucial to their success. For instance, it's very important that when a carbon cap (or renewable energy standard or other program) is enacted nationwide, that measure should not preempt states from going even further. If particular states or regions want to enact more stringent carbon caps, or more aggressive renewable portfolio (or fuel) standards this will only improve the country's environmental health and competitiveness in the cleantech marketplace – it would cost other regions nothing.

The consistency and reliability of the federal policies that are enacted is another important factor. As mentioned earlier, 37 percent of the investors participating in our survey (11 of 30) responded to an open-ended question about the barriers facing the industry by stating the necessity of having predictable, long-term policies in place. This is a strong concern of many stakeholders in the industry. Given that many cleantech companies must compete against subsidized

conventional alternatives, having supportive policies stripped away unexpectedly can wreak havoc on them. This is plainly evident in the wind installations and production tax credit (chart 2.3). Entrepreneurs and investors both need to have the ability to plan ahead beyond the end of the current fiscal year.

Example Industry: Biofuels

The biofuels industry has grown significantly since 2004 due to strong federal support coupled with ethanol replacing MTBE as an additive in gasoline. The sector has grown its annual ethanol production capacity from 1.8 billion gallons in 2001 to almost 5 billion gallons in 2006 (an average annual growth rate of 23 percent), driving much of the overall growth in cleantech investments over that same period.[92] The effects of this growth have been significant, and not just on biofuels and cleantech. It's also revitalizing rural towns in the center of the country, creating new jobs and supplying farmers with additional cash.[93] It's causing job growth in ancillary industries like farming, construction, transportation, and manufacturing.[94] With President Bush setting a new goal of 35 million gallons per year of renewable fuels consumption by 2017, the supply of biofuels will need to grow beyond corn into new technologies that are likely to come from cleantech companies.

The future of the biofuels industry in the U.S. might look a lot like Brazil's today, according to Larry Gross, CEO of Altra, a three-year-old ethanol and biodiesel producer that has raised $313 million in cash, debt, and equity to date. In Brazil, all new vehicles sold must be capable of running on ethanol or gasoline, all gas stations offer a blend of 96 percent ethanol fuel, and by the end of this year no foreign oil will need to be imported. The U.S. has some work to do to get to that point, but Mr. Gross is optimistic. According to General Motors and Ford, while it costs only about $40 - $150 more to make a "flex-fuel vehicle" compared to a conventional one, the big obstacle is the limited supply of biofuels. Toward that end, Mr. Gross noted that Altra is working on producing cellulosic ethanol in California, and he is confident that cellulosic fuels production will be the "dominant technology within ten years, if not sooner." He even likened corn-based ethanol to the "dial-up internet" of the internet. It's gotten the industry going, helping to spur on the necessary infrastructure development, but now it's time to switch to broadband. Producing cellulosic ethanol – a fuel that emits far fewer net greenhouse gases and would take much of the stress off the country's corn crop – in a manner that's cost-competitive with other transportation fuels is currently a major focus of the biofuels industry, and a critical step in reducing our country's reliance on imported fuel. Smart public policies will play a key role in helping the U.S. achieve that goal, by encouraging biofuels that produce less greenhouse gases over their lifecycle.

CHAPTER 6

CONCLUSIONS

The current advantage the U.S. possesses in the cleantech industry is a huge asset, and one that must be protected and cultivated carefully. The U.S. cleantech industry is the quintessential industry for our 21st century, resource-constrained world. Its recent period of growth provides a model for how to deal with global environmental pressures while maintaining economic expansion and profitability. While Europe and Japan are currently leading in the installation of renewable energy such as solar and wind, the majority of venture capital is focused on U.S. companies. Our policy recommendations will help ensure that the U.S. builds on its leadership and becomes the major producer of clean technologies. Looking to the future, the continued success of cleantech is critical, for it provides the key to the sustainable, modern industrial society we must become in order to survive.

While, a wide array of states and localities are currently taking commendable initiative in passing progressive policy measures to support the industry, leadership at the federal level is needed to sustain and grow the cleantech industry. As our survey has shown, private investors are influenced by the policy decisions made by the federal government. Because of the critical role played by the federal government in this process, we recommend that it quickly proceed with several important measures to boost the cleantech industry:

- To provide a level playing field for the industry we recommend creating a mandatory, comprehensive national cap on greenhouse gas emissions. This will place an added value on the societal benefits that cleantech products provide and encourage an efficient competition among all companies to reduce their environmental impacts.

- To guarantee a healthy level of demand for cleantech products we recommend initiating a national renewable portfolio standard.

- To accelerate the pace of cleantech innovation (and improve the survival rate of promising, cash-starved companies) we recommend increasing the level of public investment in cleantech R&D – either through direct grants to companies or a public-private investment partnership or matching program.

With all of these initiatives (which were strongly supported by the investors we surveyed), and any other cleantech policies that governments consider, one of the keys to their success in supporting the cleantech industry is in how they are implemented. Even a strong policy will have little effect – or even be detrimental – if it is unpredictable or inconsistent. For the health of the

industry, investors and companies need to be confident that these policies are long-term and reliable.

The past few years have been akin to a perfect storm for cleantech, with a host of different factors converging to push the industry to new levels of growth. As this report has shown, the investment community certainly appears to support this trend. To enable the U.S. to maintain its leadership position in this global industry, the federal government needs to expand its support through public policies that will both reduce our impact on the environment and create new economic opportunities for the United States.

APPENDIX I

CLEANTECH INVESTOR SURVEY

Environmental Entrepreneurs/

Cleantech Venture Network

Impact of Public Policy on Clean Technology/Clean Energy Private Equity Investing

Please fax or email completed questionnaire to James Stack:
Fax: (518) 684-1917
Email: jstack@berkeley.edu
Mobile: (510) 684-1917

Target length: 10-15 minutes

Questionnaire Objective: Over the past few years, the cleantech industry has experienced dramatic growth in the U.S. And at the same time, a number of states, large corporations, and the U.S. Congress are implementing – or considering the adoption of – a variety of new environmental public policy initiatives (e.g. AB32, RGGI, a national cap-and-trade system or RPS). Each could have ramifications on the U.S. cleantech industry. *The purpose of this survey is to understand how (if at all) state and federal public policy stances on environmental matters affect your approach to clean-tech investing.* Ten to fifteen minutes of your time will provide the U.S. an invaluable tool with which to continue advocating for the environment and the economy. Thank you!

All individual responses are confidential. Results will be used in disguised or aggregate form only, unless interviewee grants permission. Aggregate results will be shared with interviewees upon request once study is complete.

I. Demographics

1. Interviewee name:

2. Firm:

3. Contact info for follow-up or clarification of responses: (***information will not be shared with anyone***)
    a. Phone #:
    b. Email address:

4. Fund size: $__MM raised.
   Invested so far $_____MM
   Raising fund size: $__MM raising

5. Fund Status:
    a. _ Raising money
    b. _ Raised and Investing

6. In which sectors do you plan to focus the fund? (i.e. solar, fuel cells, wind, water, transportation, other sectors, etc.)
    a. Sector:_____- Estimated % of fund allocation: ____%
    b. Sector:_____- Estimated % of fund allocation: ____%
    c. Sector:_____- Estimated % of fund allocation: ____%
    d. Sector:_____- Estimated % of fund allocation: ____%

7. In which financing rounds do you primarily focus your investments? (check all that apply)
    a. Seed round _.
    b. First round _.
    c. Second round _.
    d. After company is profitable _.
    e. Mezzanine rounds __.

8. Expected regional focus of fund expenditures:
    a. _% CA
    b. _% Other U.S.
    c. _% Europe
    d. _% Asia
    e. _% ROW

II. Public Policy Impact on Clean Tech/Clean Energy Investing

(For all written answers, please take as much space as you need.)

1. What are the top three states where you expect your companies to be headquartered? Why? (take more space as necessary)

2. What can states do to better encourage clean energy/clean technology startups to locate or prosper in their states?

3. Which states do the best job of encouraging clean energy/clean technology startups?

4. Do you think a proactive environmental public policy stance can be a driver in bringing new business to the state in the clean tech/clean energy field?
    a. Yes
    b. No
    c. not sure

5. If yes, why or how:

6. Do current federal policies regarding cleantech in any way affect your likelihood to invest in U.S. companies? If yes, how?

7. Have any significant barriers to cleantech been removed in the past few years?

8. How important are the following in influencing your investments? 1 = no impact and 5 = critical to making future investments?
    a. ___ Renewable Fuels Standard
    b. ___ State renewable portfolio standards
    c. ___ AB32 (The Global Warming Solutions Act)
    d. ___ Other state programs (e.g. CSI, LCFS)
    e. ___ RGGI (Regional Greenhouse Gas Initiative)
    f. ___ Carbon markets (e.g. CCX, EU)
    g. ___ Growing public awareness of climate change
    h. ___ High energy prices

i. How important would the following potential policies be in influencing your investments? 1 = no impact and 5 = critical to making future investments?
    a. _____ National RPS
    b. _____ National cap-and-trade system (mandatory) or carbon tax
    c. _____ Greater federal subsidies for purchasing cleantech products
    d. _____ Greater federal RD&D spending on cleantech
    e. _____ A government grant program that would match private investment dollars

j. For those you identified as 5's, why are they so critical?

ENDNOTES

[1] "DOE Selects Six Cellulosic Ethanol Plants for up to $385 Million in Federal Funding" http://www.energy.gov/news/4827.htm

[2] Cleantech Venture Network; PricewaterhouseCoopers/National Venture Capital Association MoneyTree™ Report (CVN; MoneyTree). (2007). http://www.pwcmoneytree.com/exhibits/MoneyTree_4Q2006_Final.pdf.

[3] Makower, J., Pernick, R., & Wilder, C. "Clean Energy Trends 2007." Clean Edge, Inc. (2007). http://www.cleanedge.com/reports/Trends2007.pdf.

[4] DeMonte, A. "Solar Tops Q1 Cleantech Investment … Again." Red Herring. (April 3, 2007). http://www.redherring.com/Article.aspx?a=21878&hed=Solar+Tops+Q1+Cleantech+Investment+...+Again.

[5] Burtis, P., Epstein, B., & Parker, N. "Creating Cleantech Clusters: 2006 Update: How Innovation and Investment Can Promote Job Growth and a Healthy Environment." Environmental Entrepreneurs and Cleantech Venture Network, LLC. (May 2006). http://www.e2.org/ext/doc/2006%20National%20Cleantech%20FORMATTED%20FINAL.pdf.

[6] Ibid Makower et al.

[7] "Jefferies Survey Finds Cleantech Investors Bullish on Solar Power, Ethanol and Hybrid Transportation." (Press Release). Jefferies & Company, Inc. (March 5, 2007). http://www.jefferies.com/cositemgr.pl/html/OurFirm/NewsRoom/PressReleases/2007/200703051press.shtml.

[8] Ibid CVN; MoneyTree

[9] Ibid CVN; MoneyTree

[10] "CalCEF Acts to Close the Clean Energy Angel Funding Gap" http://www.calcef.org/about/recent_press.asp

[11] Cleantech Venture Network; Authors' analysis

[12] World Wind Energy Association. (2007). http://www.wwindea.org/home/index.php?option=com_content&task=view&id=167&Itemid=43

[13]"Installed PV Power as of the End of 2005." International Energy Agency Photovoltaic Power Systems Programme. (2006). http://www.iea-pvps.org/isr/01.htm.

[14] Cleantech Indices, LLC. (2007). http://cleantechindex.com/index.cfm?pageSRC=frontPage2.

[15] "Energy Assurance Daily." U.S. Department of Energy. (July 14, 2006). http://www.oe.netl.doe.gov/docs/eads/ead071406.pdf.

[16] PollingReport.com. (2007). http://www.pollingreport.com/energy.htm.

[17] Ibid PollingReport.com

[18] Stuart, C., & Hitchcock, L. "Silicon Valley, California: Cleantech Hubs." (February 26, 2007). http://www.sustainablebusiness.com/features/feature_template.cfm?ID=1425.

[19] Tesla Motors, "The Tesla Roadster Battery System" http://www.teslamotors.com/display_data/TeslaRoadsterBatterySystem.pdf

[20] "FuelCell Energy to Provide Fuel Cell Power Plants for Starwood Hotels." (Press release). FuelCell Energy, Inc. (February 17, 2005). http://www.nema.org/media/ind/20050217a.cfm.

[21] "Renewable Fuels Standard." Renewable Fuels Association. (2007). http://www.ethanolrfa.org/resource/standard/.

[22] "Regional Greenhouse Gas Initiative (RGGI)." Pew Center on Global Climate Change. (2007). http://www.pewclimate.org/what_s_being_done/in_the_states/rggi/index.cfm.

[23] Brome, H. "Economic Impact of RGGI." (Memorandum). Federal Reserve Bank of Boston. (March 3, 2006). http://www.bos.frb.org/economic/neppc/memos/2006/brome030306.pdf.

[24] "State and Trends of the Carbon Market 2006: Update: (January 1 – September 30, 2006)." International Emissions Trading Association, The World Bank. (2006). http://www.ieta.org/ieta/www/pages/getfile.php?docID=1929.

[25] The Public Benefit of California's Investments in Energy Efficiency, March 2000 http://www.rand.org/pubs/monograph_reports/2005/MR1212.0.pdf

[26] Nemet, G.F., & Kammen, D.M. "U.S. Energy Research and Development: Declining Investment, Increasing Need, and the Feasibility of Expansion." *Energy Policy*. (2007). http://rael.berkeley.edu/files/2007/NemeKamm_EP07.pdf.

[27] "The 'Green Wave' Environmental Investment Initiative." California State Treasurer's Office. (2006). http://www.treasurer.ca.gov/greenwave/index.asp.

[28] "VEETC." Renewable Fuels Association. (2005). http://www.ethanolrfa.org/resource/veetc/.

[29] "Federal Regulations: Biodiesel Tax Credits." Renewable Fuels Association. (2005). http://www.ethanolrfa.org/policy/regulations/federal/biodiesel/.

[30] "Congress Extends Import Tariff to Dismay of Some." Ethanol Producer Magazine. (February 2007). http://www.ethanolproducer.com/article.jsp?article_id=2713.

[31] "Fuel Ethanol Terminal Market Price – 18-Month History." California Energy Commission. (March 2007). http://www.energy.ca.gov/gasoline/graphs/ethanol_18-month.html.

[32] Eilperin, J., & Cohen, J. "Growing Number of Americans See Warming as Leading Threat." The Washington Post. (April 20, 2007). http://www.washingtonpost.com/wp-dyn/content/article/2007/04/19/AR2007041902527.html.

[33] Broder, J.M., & Connelly, M. "Poll Finds Majority See Threat in Global Warming." The New York Times. (April 26, 2007). http://www.nytimes.com/2007/04/26/washington/27pollcnd.html.

[34] United States Climate Action Partnership. (2007). http://www.us-cap.org/.

[35] Enkvist, P., Nauclér, T., & Rosander, J. "A Cost Curve for Greenhouse Gas Reduction." McKinsey Quarterly. McKinsey & Company. (2007). http://www.mckinseyquarterly.com/article_abstract_visitor.aspx?ar=1911&L2=3.

[36] Prior, D., & Montgomery, N. "Reducing Energy Usage Tops Corporate Environmental List, Survey Shows." Cleantech Capital Alert. (March 28, 2007). http://cleantech.com/CapitalAlert/index.cfm?cvcapitalalertID=23&cvcapitalalertstoryID=217&cvemailLink=00000185_00017525.

[37] McGray, D. "The Downhill Battle: Ski Slopes in Peril." CNN International. (March 19, 2007). http://edition.cnn.com/2007/TRAVEL/03/19/green.resorts/.

[38] Grant, J. "Ski Group Takes No Chances on Climate Change." The Financial Times. (July 16, 2005). http://www.ft.com/cms/s/d87b43ec-f596-11d9-8ffc-00000e2511c8.html.

[39] Ibid Grant.

[40] Ibid McGray

[41] Fetterman, M. "Wal-Mart Grows 'Green' Strategies." USA TODAY. (September 24, 2006). http://www.usatoday.com/money/industries/retail/2006-09-24-wal-mart-cover-usat_x.htm.

[42] LaMonica, M. "Wal-Mart Stalls Solar-Power Plan." CNET News.com. (February 28, 2007). http://news.com.com/Wal-Mart+stalls+solar-power+plan/2100-11392_3-6162850.html.

[43] "Venture Impact: The Economic Importance of Venture Capital Backed Companies to the U.S. Economy, Third Edition." National Venture Capital Association/Global Insight. (NVCA/Global Insight). (2007). http://www.nvca.org/pdf/NVCA_VentureCapital07.pdf.

[44] Kammen, D., Kapadia, K., & Fripp, M. "Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?" Energy and Resources Group/Goldman School of Public Policy at University of California, Berkeley. (2004). http://rael.berkeley.edu/files/2004/Kammen-Renewable-Jobs-2004.pdf.

[45] Sterzinger, G. "Energy: Maximizing Resources; Meeting Our Needs; Retaining Jobs." Testimony to the House Government Reform Committee Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs. (2002). http://www.crest.org/articles/static/1/binaries/repp_testimony_boston.pdf.

[46] Burtis, P., Epstein, B., & Hwang, R. "Creating the California Cleantech Cluster." Environmental Entrepreneurs and Natural Resources Defense Council. (September 2004). http://www.e2.org/ext/doc/9.8.2004CreatingCaliforniaCleantechCluster.pdf

[47] Cleantech Venture Network; Authors' analysis

[48] Parker, N., & O'Rourke, A. "The Cleantech Venture Capital Report – 2006." Cleantech Venture Network, LLC. (January 2006). http://cleantech.com/Publications/Capital_Report_2006_Abstract.pdf.

[49] Parker, N. "The Globalization of Cleantech: Data, Trends & Forecasts". (Presentation, Cleantech Forum XII-Frankfurt). Cleantech Venture Network.(May 15,2007).

[50] California Climate Change Center, "Economic Growth and Greenhouse Gas Mitigation in California" http://calclimate.berkeley.edu/

[51] "BP Selects Strategic Partners for Energy Biosciences Institute." (Press Release). BP. (February 1, 2007). http://www.bp.com/genericarticle.do?categoryId=2012968&contentId=7028142.

[52] "Gov. Schwarzenegger Signs Landmark Legislation to Reduce Greenhouse Gas Emissions." (Press Release). Office of the California Governor. (September 27, 2006). http://gov.ca.gov/index.php?/press-release/4111/.

[53] Hanneman, W. M. "Review of Economic Arguments Against AB32." University of California Climate Change Center. (August 2006). http://www.e2.org/ext/doc/Review%20of%20Economic%20Arguments_Hanemann.pdf.

[54] Stern, N. "Stern Review on the Economics of Climate Change." HM Treasury. (October 2006). http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

[55] "A 125-Year Picture of the Federal Government's Share of the Economy, 1950 to 2075." Congressional Budget Office. (June 2002). http://www.cbo.gov/showdoc.cfm?index=3521.

[56] "Environmentally Preferable Purchasing." U.S. Environmental Protection Agency. (2006). http://www.epa.gov/epp/pubs/about/about.htm.

[57] "Iowa Governor Orders Greater Use of Efficiency and Renewable Energy." U.S. Department of Energy. (April 2005). http://www.eere.energy.gov/state_energy_program/news_detail.cfm/news_id=9014.

[58] "Governor Signs 'Green Buildings' Executive Order to Raise Environmental and Energy Efficiency Standards in State Buildings." (Press Release). Office of the Governor of Wisconsin. (April 11, 2006). http://www.wisgov.state.wi.us/journal_media_detail.asp?locid=19&prid=1905.

[59] "EPA's Use of Renewable Technologies." U.S. Environmental Protection Agency. (2006). http://www.epa.gov/oaintrnt/energy/renewtech.htm.

[60] "Model Programs for Environmentally Preferable Purchasing (EPP)." Minnesota Office of Environmental Assistance. (2004). http://www.pca.state.mn.us/oea/lc/purchasing/resources.cfm.

[61] "Iowa Governor Orders Greater Use of Efficiency and Renewable Energy." U.S. Department of Energy. (April 2005). http://www.eere.energy.gov/state_energy_program/news_detail.cfm/news_id=9014.

[62] "Governor Signs 'Green Buildings' Executive Order to Raise Environmental and Energy Efficiency Standards in State Buildings." (Press Release). Office of the Governor of Wisconsin. (April 11, 2006). http://www.wisgov.state.wi.us/journal_media_detail.asp?locid=19&prid=1905.

[63] "Gov. Schwarzenegger Signs Landmark Legislation to Reduce Greenhouse Gas Emissions." (Press Release). Office of the California Governor. (September 27, 2006). http://gov.ca.gov/index.php?/press-release/4111/.

[64] Collier, R. "'Cap and Trade' Gaining Favor: Congress Taking up Business-friendly Proposals to Reduce Global Warming." San Francisco Chronicle. (March 21, 2007). http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2007/03/21/BUGVQOGJM4135.DTL.

[65] "Senate Bill No. 1368." California Energy Commission. (September 29, 2006). http://www.energy.ca.gov/ghgstandards/documents/sb_1368_bill_20060929_chaptered.pdf.

[66] "California Solar Initiative Handbook with SB1/CSI Draft Decision Noted." California Public Utilities Commission. (December 19, 2006). http://www.gosolarcalifornia.ca.gov/documents/CSI_HANDBOOK.PDF.

[67] Lucas, G. "Bold Move on Global Warming: A World First: Governor to Order New Standard to Reduce Carbon Content of Motor Fuels." San Francisco Chronicle. (January 10, 2007). http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2007/01/10/MNGMPNG4LD1.DTL.

[68] "Gov. Schwarzenegger Issues Directive to Establish World's First Low Carbon Standard for Transportation Fuels." (Press Release). Office of the Governor of California. (January 9, 2007). http://gov.ca.gov/index.php?/press-release/5074/.

[69] "California, New York Agree to Explore Linking Greenhouse Gas Emission Credit Trading Markets; Gov. Schwarzenegger Tours Carbon Trading Floor." (Press Release). Office of the Governor of California. (October 16, 2006). http://gov.ca.gov/index.php?/press-release/4449/.

[70] "Five Western Governors Announce Regional Greenhouse Gas Reduction Agreement." (Press Release). (February 26, 2007). http://www.pewclimate.org/docUploads/2007-02-26%20NGA%20greenhouse%20gas%20event%20release.pdf

[71] "New DC Buildings to Go Green: Historic Bill Passes Council." (Press Release). Office of Jim Graham, D.C. Ward One Councilmember. (December 5, 2006). http://www.grahamwone.com/graham_press/id,67/Itemid,14/.

[72] "Boulder Voters Pass First Energy Tax in the Nation." (Press Release). City of Boulder. (November 8, 2006). http://www.ci.boulder.co.us/index.php?option=com_content&task=view&id=6136&Itemid=169.

[73] "An Act Concerning Clean Cars." State of Connecticut Senate, Bill No. 660. (2006). http://www.cga.ct.gov/2006/ACT/PA/2006PA-00161-R00SB-00660-PA.htm.

[74] "New York State Sets Efficiency Standards for Appliances." U.S. Department of Energy. (August 3, 2005). http://www.eere.energy.gov/state_energy_program/news_detail.cfm/news_id=9250.

[75] "New Energy Conservation Tax Incentives for Individuals." (Memorandum). State of South Carolina Department of Revenue. (October 5, 2006). http://www.sctax.org/NR/rdonlyres/0D5CBB97-1A9F-466E-99F2-3FBC9B09E219/0/IL0623.pdf.

[76] "South Carolina Incentives and Laws." U.S. Department of Energy. (2007). http://www.eere.energy.gov/afdc/progs/view_all.cgi?afdc/SC/0.

[77] "Solar America Initiative." U.S. Department of Energy. (2007). http://www1.eere.energy.gov/solar/solar_america/.

[78] "California Solar Initiative Proposed Research, Development and Demonstration Plan." California Public Utilities Commission. (April 2, 2007). http://www.cpuc.ca.gov/static/energy/solar/mar07_staff_csi_rd_proposal.pdf.

[79] "California Clean Energy Fund: Overview." CalCEF. (2005). http://www.calcef.org/about/index.asp.

[80] "California Clean Tech Open: 2006 Competition Report." California Clean Tech Open. (2006). http://www.cacleantechopen.com/docs/pdf/CCTO_2006_CompetitionReport.pdf.

[81] "Massachusetts Green Energy Fund." Massachusetts Renewable Energy Trust. (2007). http://www.mtpc.org/renewableenergy/mgef.htm.

[82] Kaufman, M. "NASA Invests in Its Future With Venture Capital Firm." The Washington Post. (October 31, 2006). http://www.washingtonpost.com/wp-dyn/content/article/2006/10/30/AR2006103001069.html.

[83] "Sweden and California Sign Agreement on Developing Renewable Fuels." Associated Press. (June 15, 2006). http://www.highbeam.com/doc/1P1-125260180.html.

[84] Riechmann, D. "Bush Heralds Biofuels Pact Friday With Brazilian Leader." Associated Press. (March 9, 2007). http://news.bostonherald.com/international/americas/view.bg?articleid=187428.

[85] "Tax Incentives for Petroleum and Ethanol Fuels." U.S. Government Accountability Office. (September 25, 2000). http://www.gao.gov/archive/2000/rc00301r.pdf.

[86] Messinger, L. "Cleantech: Climate Change Hero?" Red Herring. (April 10, 2007). http://www.redherring.com/Article.aspx?a=21949&hed=Cleantech%3A+Climate+Change+Hero%3F.

[87] "Major Businesses and Environmental Leaders Unite to Call for Swift Action on Global Climate Change." (Press Release). United States Climate Action Partnership. (January 22, 2007). http://www.us-cap.org/media/release.pdf.

[88] Herbst, M. "Investors Call on Congress to Go Green." Business Week. (March 20, 2007). http://www.businessweek.com/bwdaily/dnflash/content/mar2007/db20070320_535194.htm?chan=top+news_top+news+index_top+story.

[89] Davies, F. "Silicon Valley Leaders: Political Climate Right for 'Green Tech.'" San Jose Mercury News. (March 15, 2007). http://www.mercurynews.com/search/ci_5440875.

[90] "Green Technologies: An Innovation Agenda for America." TechNet. (2007). http://www.technet.org/resources/GreenTechReport.pdf.

[91] Richtel, M. "Start-up Fervor Shifts to Energy in Silicon Valley." The New York Times. (March 14, 2007). http://www.nytimes.com/2007/03/14/technology/14valley.html?ex=1176609600&en=678b72b953a2ae32&ei=5070.

[92] "Industry Statistics." Renewable Fuels Association. (2007). http://www.ethanolrfa.org/industry/statistics/.

[93] Egan, T. "The Nation: Refueled; Life on the Ethanol-Guzzling Prairie." The New York Times. (February 11, 2007). http://select.nytimes.com/search/restricted/article?res=F30D17F9355B0C728DDDAB0894DF404482.

[94] Fitzgerald, A. "Ethanol Growth Helps Spur Jobs in Wide Array of Fields." Des Moines Register. (February 11, 2007). http://desmoinesregister.com/apps/pbcs.dll/article?AID=/20061103/BUSINESS/102120031.