

**Venture Capital Investment in the Greentech Industries:  
A Provocative Essay\***

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In the first decade of the 21<sup>st</sup> Century there has been increasing awareness of environmental issues and recognition that these are now global in scope. This has occurred for many reasons and is perhaps best epitomized in the global warming discussion. The dramatic rise of China and India, in particular, reoriented the debate about the sustainability of the current trajectory of fossil fuel usage and environmental degradation. Quite simply, if the economic growth of China, initially, and then India were to follow the historical trajectory of fossil fuel energy usage and resource consumption that Japan, Taiwan, and Korea followed, the environmental impacts would be nothing short of monumental.

This paper does not propose to debate the need for “green technologies” or the merits of particular technologies. It accepts the current trajectory of the fossil fuel-based energy system is not sustainable, environmentally or ethically. Evaluating the merits of particular energy generation or environmental technologies is beyond the scope of this paper and, perhaps, at this early stage unknowable. Rather, the paper addresses the question of whether venture capital (VC) in its current organizational form offers significant promise for funding the commercialization of what we will term “Greentech.” To presage the following discussion, this paper is skeptical about the possibility that VC investment can become an important component of the financing of Greentech. This is mainly because the investment criteria for successful venture investing are unlikely to be met by most Green technologies. This is a contrarian perspective as the promise of VC financing for Greentech and the potential of Greentech as a new field of venture investing has already received enormous amounts of interest and hype in the global press and from elements of the venture community. In the academic literature, interest in VC investing in various Green technologies has increased (Bürer and Wüstenhagen 2009;

Wüstenhagen and Teppo 2006; Wuebker 2009; Wüstenhagen et al. 2009). Despite these pioneering efforts, understanding of Greentech VC investment is still limited.

From a public policy perspective there are reasons to support private VC investment over other more direct corporate subsidy programs. Market-oriented economists would argue that private VC investment is desirable because it eliminates the need for public decision making on which technology or firms should receive funding. This limits the role of government in decision making and trying to “pick” winners – a problem that has gotten significant attention in the energy and industrial policy literature (Helm 2002; Pack and Westphal 1986). This position is in particular strongly held in Anglo-Saxon market-centered nations such as the U.S. and U.K. For the market-oriented economists, the market in the form of VC or other investors will discover, fund, monitor, and assist their Greentech portfolio firms. Proponents of this model in general would confine governmental involvement to funding research and ensuring that markets operate transparently and in a non-discriminatory fashion.

An entirely different group of observers argue that independent VC investing in Greentech should be encouraged because it is not subject to the sunk costs, entrenched interests, and biases of established energy firms and government regulators (Hockerts and Wüstenhagen 2009). For them, VCs, with their willingness to support new technical solutions and/or business models, offer hope for change. These advocates observe that in their investment policies independent VCs are not influenced by legacy costs and decisions and thus can finance firms whose success would portend the creative destruction of incumbents. Their goal is that VC-supported entrepreneurship should prove sufficiently disruptive so as to transform the economic environment.

The analysis in this paper focuses exclusively upon dedicated VC limited partnerships, the dominant form of formal venture investing globally. Excluded from direct examination are corporate VC operations<sup>1</sup> and angel investors, both of which have different processes, logics, and goals from professional venture investors.

Understanding the potential for building a successful VC practice in Greentech investing begins with a description of the VC life cycle and the economics of the industries within which VCs have typically invested. The next section considers the question of whether Greentech is a single industry or a variety of industries. This is important because successful VC investing is predicated upon developing deep knowledge of the evolutionary trajectories of technologies and markets. The decision to invest in new sectors is largely determined by the possibility of that the investments will provide sufficiently large returns. A tentative answer to questions about returns can be given by examining previous returns. Because the historical record may provide insight into the trajectory of this Greentech investment boom, the penultimate section briefly describes the VC response to the 1973-1980 Oil Crisis period, during which there was a wave of VC investment in the Greentech of that time, i.e., alternative energy. The conclusion questions the possibility that Greentech will prove to be a lasting investment interest for VCs, and suggests that the current investment boom may be an unsustainable bubble.

## **The Venture Capital Life Cycle and the Operation of the Typical VC Firm**

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<sup>1</sup> Teppo and Wüstenhagen (2009) find that many corporate venturers, particularly the energy companies that began operations between 1999-2002 had discontinued their operations. They attribute this to a clash between the VCs and their parent firm's organizational cultures. An observation that is undoubtedly true, but has also been true in the case of nearly every corporate venture operation over the last forty years. The sole exception to this is Intel Ventures, which is approximately twenty years old and still active.

From 2006 through the first quarter of 2009, there has been a rush by U.S. and European VCs to raise Greentech funds. Continuation, rather than episodic VC involvement in Greentech investing, will require that the candidate Greentech recipient firms eventually, if not initially, develop the characteristics of successful VC portfolio firms in terms of rates of growth and desirability to post-VC investors. The investments must offer sufficient returns to allow VCs to raise more money for future investments (Gompers and Lerner 1999). In other words, Greentech must allow each stage in the cycle to be completed or VC investment in Greentech will end. Most importantly, regardless of the social benefits – which may have attracted the VC fund’s initial investors – without sufficient financial success to justify the investment, investors such as pension funds and endowments will discontinue advancing money to the VCs, though governments may invest in VC funds even if the investments are failures as a part of a larger social goal, such as supporting Greentech firms. To be sustainable, private Greentech investing must be sufficiently profitable to justify continuing funding, and only profitability can ignite a self-reinforcing entrepreneurial dynamic capable of making a difference in the trajectory of global warming and environmental pollution.

The basis of the VC industry is to invest in firms early in their life cycle and then to sell these investments to others later in the life cycle – hopefully with capital gains. This paper deals only with the VC limited partnerships, though the field of investing in small firms includes private individuals or groups (often termed “angel” investors), corporate venture capitalists, and, less frequently, various government agencies. Today’s VC firms generally raise investment capital through partnerships with institutional investors and wealthy individuals who, as limited partners, commit their capital for ten years. For the limited partners, the attraction is the promise of returns significantly greater than could be achieved with conventional investments.

Diversification has also been mentioned as a benefit from investing.<sup>2</sup> The VCs are the general partners responsible for the investment decisions.

The economic interests of the general partners explain their behavior. The VCs receive an annual management fee of between 2-3% of the capital managed and a share of any profits (usually 20-30%) after the initial capital committed by the LPs is returned. Prior to the 1980s, average VC fund size was below \$100 million. With a 2 percent management fee, a VC firm managing a \$100 million fund took in \$2 million to pay salaries and expenses. If a VC firm had two active funds, then the income was \$4 million per year. If there were 5 partners and each managed approximately \$40 million in 8-10 portfolio firms, then each partner's share of the management fee was \$800,000 minus expenses. In the 1990s the size of the funds mushroomed, and by the mid 1990s it was not unusual for firms to raise \$500 million to \$1 billion funds. Even if management fee percentages were not raised – and in some cases they were – the management fees grew to between \$10-20 million per fund. If the VCs managed two funds, the income was \$20-40 million per year, and each individual's share was \$8,000,000 minus expenses. Even if the number of partners tripled and each now managed \$125 million, the individual partner's share of the management fee was \$2.5 million minus expenses. The new economics meant each partner received a handsome salary for ten years (the life of each individual fund), whether the investments were successful or not. Today, a VC can become wealthy without even generating a

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<sup>2</sup> This paper is not the venue to discuss the notion that “diversification” is, in and of itself, a good investment idea. Were that to be so, buying lottery tickets would be an investment strategy. The available data on VC returns show that it is the top quartile that make the outside returns, the remainder do not perform as well as the S&P Index (Kaplan and Schoar 2005). According to Teresa Barger (2002), from 1980-1995 an investor who could not have gotten into the top 25% of the VC funds, would have had a 1.9% compound annual rate of return in investing in an index fund of listed equities. What this suggests is that if an investor cannot get into a top-tier firm, diversification will only lead to under-performance. This is the fallacy that so many make when they allocate x% to venture capital investing. Performance is not improved by an abstract median percentage return, but rather by the returns of specific funds. If one cannot enter these funds and since there is little turnover in the investors in the top quartile funds, then investment performance will be poor (see, among others, Kaplan and Schoar 2005).

good return for the limited partners. Thus the simple act of raising a large fund is a guarantee of a significant income for ten years. In effect, if the limited partners want VCs to manage a targeted fund, the question of its long-term investment potential is of little importance to the VCs. Notice the difficulty that the limited partners may create for themselves; they might be making a long-term largely irrevocable decision to invest in what could be the latest technological fad – a dangerous investment strategy.

### **Greentech versus Traditional VC-Financed Industries**

Prior to discussing the limited research on VC investing in Greentech, it should be noted that in terms of venture investing, there is no definitive definition of Greentech. At this time it appears to be an amalgam of a number of industries. If this is so, then consider the obstacles to a sustained program of VC investment. First, venture capitalists will find it difficult to specialize and deeply understand the business space. This suggests that a community of investors may not coalesce, thus limiting an ongoing flow of capital from increasingly experienced investors. This contributes to what may become a second obstacle. Many of the industries in which VCs have been most successful are characterized by firms opening what Joseph Schumpeter termed “new economic spaces” within which there is a swarming of new firms. This also plays to the VCs’ strength, which is the ability to peer just over the horizon to see what the next step in the technology/business evolution might be and to create a firm to occupy the space before incumbents or adjacent existing firms can react (Burg and Kenney 2000). The development of the Internet space illustrates this. Early browsers such as Netscape allowed more people to discover the fledgling web. This increasing viewership made it possible for market software to

build websites. The increase in websites and viewers allowed new entrants to begin online sales, i.e., Amazon, eBay, Expedia, Etrade etc. The growth of the web made it possible to have portals such as Yahoo!, Lycos, and Excite, as well as search engines, e.g., Google. After this came webscraping, wikis, blogs, and a myriad of other economic activities (Kenney 2003). It is these burgeoning technology/economic spaces that create the investment frenzies and the outsize returns for the VCs. Are there Greentech technologies or market developments that will allow VCs to invest in the creation of a myriad of firms, thereby sparking the formation of a new ecosystem? To illustrate, in biotechnology, which after IT has been the most important are of VC investing, there have been a sufficient number of successes to permit the creation, survival, and reproduction of biotechnology specialist VC firms and an ecosystem of support organizations.

In the case of biotechnology, a number of authors have noted that it was the availability of VC that allowed an industry consisting of entrepreneurial firms to be established outside the pharmaceutical industry (Kenney 1986, Pisano 2006). The attraction of biotechnology has been the development of new and superior drugs that could demand premium prices in the market. Despite a relative paucity of commercial success, biotechnology firms have offered sufficiently high returns to their VC investors. Will Greentech produce venture investing successes such as Genentech and Amgen? What is the likelihood that Greentech will produce firms such as Intel, Cisco, Google, and Oracle? For the VCs to have a long-term interest in Greentech, it must perform as well as biotechnology. If a sufficient number of such successful investments are not made, then VC investment in Greentech is likely to precipitously decline, stranding portfolio firms as the hype ends.

VCs have also invested in other industries outside of the IT and biomedical fields. In fact, VCs are agnostic regarding industrial areas. So, for example, the well-known firm Federal Express received VC funding, as have a number of airlines such as the now defunct People Express. The San Francisco brewery Gordon Biersch, which has rapidly expanded, was also the beneficiary of VC financing. All of these were successful investments leading to important IPOs, however VCs did not become significant sources of capital for the package delivery, airline, or microbrewery industries. This is not because entrepreneurship is impossible in these industries, but because there is a relative paucity of the types of opportunities that VCs are comfortable funding. Put simply, VCs are not biased against particular industries; rather they invest in opportunities that are appropriate to their organizational goals.

There has been comparatively little research on VC investment patterns by industry. What industry-level research exists has been concentrated on biotechnology and the information technologies (see, on the Internet, Zook 2005; Kenney 2003; on biotechnology, see Powell et al. 2002; Baum and Silverman 2004, on data communications equipment, see Burg and Kenney 2000). As a comparatively recent phenomenon, Greentech VC investing has received little attention in the scholarly press, but enormous attention in the popular press. The major exception is the important paper by Wüstenhagen and Teppo (2006) examining the available evidence regarding VC investing in Greentech firms. Of the four Greentech firms they examined that went public on the NASDAQ in 1999 to 2000, one is no longer listed, two are penny stocks (trading under \$1), and one was delisted. In the case of three of these firms, the VCs made adequate returns – a situation that is expected if VCs can make a public offering. The fourth firm Plug Power, which had the best return (not at the time of IPO, but at the end of the share lock-up expiration date), was not VC financed; rather it was a spin-off joint venture. These three

successful VC-backed IPOs show that Greentech firms can be successful, but does not provide sufficient evidence of the return to total VC investment in the industry. Consider the most successful U.S. solar photovoltaic firm, First Solar, which was founded in 1984. In 1999 it was sold to the Walton family (Heirs to the Wal-Mart fortune). The stock was sold to the public in 2006, seven years later – a comparatively long time to IPO.

Greentech (formerly alternative energy/environment) has a long history of attracting investors with only limited returns. As Figure One indicates, from 1995-2000 far more capital was invested in the Industrial/Energy category than was returned in the initial public stock offerings. Unfortunately, we do not have data on the number of mergers that occurred. What this suggests is that more capital was invested in the Industrial/Energy category than was returned through exits – not a sustainable situation. The Industrial/Energy category in terms of investment roughly tracked the collapse in total VC investment, suggesting that it did not perform differently than other VC investing in the aftermath of the Internet Bubble.

#### FIGURE ONE ABOUT HERE

Energy-focused VC funds in the European context may offer more attractive returns (Wüstenhagen and Teppo 2006). This may be either because European VCs require a lower hurdle rate to measure an acceptable return or the European entrepreneurs are superior. Also, because European stock markets such as the London AIM have less rigid criteria and require less documentation for exits, smaller firms can be listed allowing VCs to recoup their investments. From an American perspective, there has not yet been a Greentech Google, Yahoo!, or Cisco providing the 100 times returns that offset the many unsuccessful VC investments must make. To return to First Solar, it had a market capitalization of approximately \$12 billion in 2009.

Despite its success, its value is one order of magnitude smaller than Google, which in 2009 had a market capitalization of \$134 billion. In terms of the larger picture, are there many more First Solar level of successes in photovoltaics? In IT there may be another Google. For example, in the last three years there has been Youtube (after 18 months purchased for \$1 billion), Facebook (recent valuations suggest it is worth \$6 billion), and Twitter (recent valuations suggest it may be worth \$1 billion or more). Are the potential returns similar for Greentech start-ups?

It may be possible that the returns are not as large, but the other question is will they be sufficient? This is more difficult to answer, as it is contingent upon the relative receptivity of public markets to Greentech firms, government action, price of alternatives, and the quality of the firms and managers involved. This section has suggested that thus far opportunities as large and lucrative as those in IT have not been created in Greentech. Whether there will be sufficiently large returns to justify investment from VC firms operating under the current Silicon Valley model is not yet knowable. It is also uncertain that the VC model can be reshaped to justify lower returns, and how that might be done.

### **Greentech and Venture Capital**

How do VC economic dynamics apply to Greentech? An illustration from recent fund raising may clarify the problematic nature of the current VC environment. Many Greentech advocates were excited when in May 2008 one of the elite VC firms Kleiner Perkins Caufield & Byers (KPCB) announced that it had raised a \$500 million Green Growth investment fund (KPCB 2008). As FIGURE ONE demonstrates KPCB was fortunate as the fund was subscribed at the exact peak of the 2008 oil price bubble and the Greentech/Alternative Energy fever.

Regardless of the fate of the fund, as far as returns are concerned, KPCB will reap significant benefits as it collects its 2.5% annual management fee or \$12.5 million per year no matter what the returns are to investors.

While VCs are typically agnostic to the industry they invest in, there is a path dependent component of the practice because they continue and even increase investing in industries where they experience success. In fields in which investment returns are low, there is a marked tendency to throttle back investment, e.g., few any longer invest in nanotech firms (and this field was hot less than five years ago). There is a recognition of the importance of path dependence for VC investing in Greentech. For example, Wüstenhagen and Teppo (2006) find that VC investment in Greentech requires knowledge and experience, but what they overlook is that path dependence requires the building of routines that buttress a path that can only come from the positive reinforcement of previous successes that legitimize the investment field (see, von Burg and Kenney 2000). What is necessary to continue the flow of investment is the tangible possibility of a significant return. It is for this reason that many have called venture investors “lemmings,” as they chase after the newest “hot” industry or investment idea. As long as there are successful exits the investment will continue – they only stop investing in the field after experiencing a sufficient number of failures.

The difficulties with Greentech investments are well described by Scott Carter, partner at Sequoia Capital:

There's going to be a massive amount of money lost in Cleantech over the next few years although Obama's presidency will probably give it new life for awhile. But that doesn't mean we're not fans of Cleantech and alternative energy. We've been actively investing for three years, but we have one golden rule, which is investing where low capital expenditures are required. That means a big part of the market is a lot less appealing to Sequoia Capital. We view innovation in Cleantech as we do in other technology sectors.

If you have great entrepreneurs who are incredibly frugal, who really focus on delivering a product that solves an immediate need, and you apply those principles to Cleantech, then you're going to make money. (Ernst and Young 2009: 12)

Carter understands that there is already overinvestment in the sector, which is, of course, dangerous. He goes further in stating that short-term success will be due to government intervention – hardly a strong incentive for public markets or larger firms to acquire a VC-funded Greentech firm, particularly if the direction government mandation is unclear or erratic. Carter then states the obvious that many segments of Greentech are not interesting to elite Silicon Valley VCs. There is a possibility that these capital-intensive sectors will be interesting to less sophisticated VCs, or to those that have a lower investment hurdle rate, only time will tell.

Given that Greentech is an enormous and amorphous category, there will undoubtedly be investment opportunities for venture capitalists. Most likely, these opportunities will resemble those that have some of the characteristics of current VC investment areas. In cases where there might be the construction of new infrastructures, there may be significant investment opportunities in providing components or software. For example, though somewhat ill-defined, the roll-out of a “smart” electrical grid could offer significant opportunities for the establishment of new software firms and possibly firms creating communications devices to transmit data through the grid itself. Though most of the focus has been on energy generation, there may be significant opportunities in energy efficiency fields where new materials could create significant cost savings in products produced in great numbers. For example, new technologies may create more efficient lighting systems and the volume of such a consumer product is sufficiently large to be able to generate a good return. Finally, there may be superior materials able to receive intellectual property protection that could eliminate serious environmental hazards. Many of

these innovations would not be as highly tied to the energy generation paradigm that drives Greentech investment thinking every time fossil fuel energy prices rise.

The pattern of VC investing in the Industrial/Energy category for the last fourteen years, as Figure Two shows, is highly correlated with the price of oil. Of course, there is a similar correlation in the interest of public stock markets in Industrial-Energy firms. The implication for VC investors is that when they make investments predicated upon a high cost of energy, if energy prices fall, so will the value of their portfolio firm. In cases in which their investments are capital-intensive, the loss in market value will be immediate, unless some other variable such as government interventions, legal requirements, or subsidies, can overcome the market decision. It is also important to note that when energy prices fall, the hype surrounding Greentech firms also falls, thereby discouraging potential follow-on investors including public markets, potential corporate investors, and other VCs. As **Figure One** shows, since 1995 there have been two significant bursts of VC investment in the Industrial/Energy category, 1999-2001 and 2006-2009. Each of these was followed by a precipitous investment collapse. **Figure One** also shows that Industrial/Energy VC investment has roughly tracked the overall VC market and software except in mid 2005, when it expanded rapidly while software and total VC remained stagnant. This also captures the increasing concern about global warming highlighted in Albert Gore's movie *An Inconvenient Truth* and the apparent spiral in energy costs attributed to the rise of China and India. Thus, some in the VC community have been led to believe that these two factors created a powerful market discontinuity that could be filled by VC. Former vice president Gore was invited to join one of the most elite VC firms in the world, KPCB, as a special limited partner.

FIGURE TWO ABOUT HERE

In the last fifteen years there have been two spikes in VC investment in the Industrial/Energy category. In the first case, from 1999-2001 there seems to have been an acceptable return on the investment for the promoters and VCs based upon calculations from the Greentech IPOs, but public investors who bought these stocks and held them have experienced terrible returns (Wüstenhagen and Teppo 2006) – a recipe for creating public investors skeptical of Greentech promises. The second spike of VC investment began in late 2005 and has declined precipitously due to the stock market crash that began in 2008. The decline is not surprising when one considers that Greentech IPOs globally have collapsed (Milunovich 2009). Even worse is the number of large secondary offerings undertaken as troubled firms were forced to raise capital. Whether this is the result of declining Greentech opportunities or larger market forces is unclear at the moment.

### **Historical Parallels?**

Energy costs have had an important influence on Greentech investment. There are parallels with the increase in oil prices experienced in 2007-2008. In the ten years beginning in 1973 there were, in quick succession, two oil crises due to the 1973 Arab-Israeli War when the Arab world imposed an Oil Embargo, and then in 1980 when the Shah of Iran collapsed. Oil prices spiked massively, prompting a belief that Global Peak Oil was imminent and an argument about the necessity of developing alternative energy sources (e.g., Akins 1973; Tanzer 1974). Today, as then, the question often raised was who should make the investments in alternative energy? Though the data is spotty, when oil prices spiked in the 1970s and early 1980s a number of VCs, believing in the Peak Oil Hypothesis, invested in energy production and alternative

energy resources.<sup>3</sup> **Figure One** indicates that in the 1980s, VC investment in the industrial/energy category spiked. However, by the late 1980s VC investment in the industrial/energy category dropped dramatically. One aspect of this was the drop in fossil fuel energy prices, but there are other insights that can be taken from this experience.

#### FIGURE ONE ABOUT HERE

A simple economic interpretation of the collapse of VC investing in Industrial/Energy category may be too facile. A more detailed explanation is the fact that these types of investments may not suit VC-based investment. In a fascinating article, Raghu Garud and Peter Karnoe (2003) compare Danish and U.S. models for entering the wind turbine industry, providing insight into why the U.S. largely failed, while Denmark successfully built a globally competitive industry. An important obstacle to U.S. success was that the U.S. wind turbine industry adopted a high-technology aerospace development model in the late 1970s and early 1980s, in search for technical breakthroughs – exactly the types of firms VCs seek to fund. Ultimately, this strategy proved to be inferior to more collaborative and initially low technology model adopted by the Danes. The Danish experience applies to the current alternative energy investment boom. Much of the equipment to be produced will require investments in manufacturing, which benefits from incremental improvements and in some cases large capital investments. Such firms often exhibit relatively slow growth (5-15 percent per annum) as opposed to the most successful VC-funded firms that grow at 50-100% per annum. This slower growth is not as attractive for VC investors. As Garud and Karnoe so effectively describe, the Danish success was a relatively slow evolutionary process where improvements came gradually and in increments too small to justify VC investing. With the wind turbine industry, a cluster of

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<sup>3</sup> This paper takes no position on whether global Peak Oil has been reached.

dedicated suppliers formed to supply the turbine assemblers. But these firms were relatively small and often were existing firms operated by skilled craftsmen who simply repurposed their knowledge of material forming for the growth of the wind turbine industry. By contrast, in Silicon Valley a cluster around the rapidly growing semiconductor industry consisting of semiconductor equipment, design software, and materials suppliers also formed, but these were usually de novo firms. Their growth was rapid and profitability was high, therefore justifying VC investment.

If most Greentech technologies and industries evolve incrementally with few industry-changing breakthroughs, there may not be the same types of investment opportunities that have been seen in the information technologies and university-born human pharmaceuticals. To illustrate the different industry dynamics, the efficiency of wind turbines in converting wind to electricity, or solar photovoltaics in converting sunlight to electricity, have experienced improvements at 1-2 percent per year. Moreover, they are bounded at 100 percent efficiency. In contrast, the electronics industries driven by Moore's law experience operational improvement of approximately 100 percent in 18 months, and there is no obvious upper limit. The point is not to deny that economically significant improvement occurs in Greentech, but rather to observe that they have proceeded rather slowly. A slow pace of incremental improvement may not provide sufficient competitive advantage for a new entrant to overwhelm incumbents.

Market growth is also important. As the success of hybrid and electric vehicles demonstrates, the Greentech market is expanding rapidly – though this is a relative measure. However, to access these growing markets the Greentech startup must displace incumbents with a similar, though possibly inferior, product. To provide an example, a number of electric automobile firms have been funded by wealthy individuals and VCs. The task for these firms is

to unseat existing competitors such as Honda, Nissan, and Toyota, all of which also have significant alternative energy research programs that can be combined with complementary assets such as dealer and supplier networks, capital, and strong manufacturing expertise. Attacking such firms head-on is a risky business strategy. The historical lesson has been that VC investment has been most successful when there are no incumbents or the incumbents have an entirely different business model, hence Netflix, which delivers videos through the mail, outflanked video stores that required customers to travel to the store.

Green technologies have significant commercial promise particularly if governments mandate their usage. For the VC investor, though, the obstacles to successful investment are daunting. A high level of manufacturing expertise may be required and the amount of capital investment can be too large. A common solution to this problem for VC-backed electronics firms has been to out-source manufacturing. In cases where the product is entirely new and there is little manufacturing expertise, the establishment of in-house production and an active program of incremental improvement might be necessary – but this consumes capital.

### **Waiting for Godot or Government Subsidies?**

There is a long history of argument from Alternative Energy and Greentech supporters stating that since they internalize costs of pollution externalized by fossil fuels they deserve extra-market compensation.<sup>4</sup> Again, this is something that this paper acknowledges but will not dwell upon. Greentech investing is and will continue to be more difficult than IT and even

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<sup>4</sup> It is an undisputed fact that fossil fuel energy in the U.S. has been and continues to be the beneficiary of massive governmental subsidies.

biotechnology due to the dependence of success on non-market factors. Whereas VCs are comfortable dealing with market, technology, and personnel risks, government policy poses another risk for Greentech (for another perspective see Bürer and Wüstenhagen 2008; 2009). In this realm the venture capitalists and their small firms may be competing in lobbying against corporate giants that have more capital and stronger connections to lawmakers. Investing in lobbying is expensive and unproductive for a smaller firm.

For a VC investor – whose firms are “burning” cash – waiting for the government mandation of certain standards or technologies or the appearance of subsidies is dangerous. For example, in 2006 Vinod Khosla, a former Kleiner Perkins partner began “financing a California ballot initiative to fund alternative energy initiatives through tax hikes on oil companies (Associated Press 2006).” Though defeated, it was perhaps the first time VCs had proposed that the public begin subsidizing the firms in which they invested. Today, many VCs are hoping that Obama’s stimulus will improve the prospects for their portfolio firms. This suggests that VCs have doubts about the financial viability of Greentech. In effect, Greentech investments may not be able to succeed in the market within which they find themselves, but rather must wait for an outside source to change their market.

For advocates of Greentech, there is another concern, namely that government regulation will choose winners, commercialization models, or lock-out better alternatives. The U.S. government decision, in large part driven by lobbyists from factory agriculture and large multinationals, to mandate the use of ethanol may be moving the U.S. in the wrong direction environmentally. Another case is the recent decision to provide \$500 million in loans to the partially VC-financed, Silicon Valley electric car maker, Tesla Motors, whose sole product is an all-electric sports car. The point is not to critique the bad policy decisions. This discussion

recognizes that VC investors will not choose the “right” or beneficial technologies. For example, Kleiner Perkins Caufield & Byers (KPCB) has invested in Altra Inc., which is California’s biggest producer of ethanol. KPCB has also testified to the U.S. Congress in favor of mandating greater ethanol usage. Ultimately, VCs are agnostic regarding technologies. Their primary purpose is, as it should be, the capturing of out-size returns that justifies their investment practice – a purpose that can be traced back to the pioneers of the VC industry such as American Research and Development (Hsu and Kenney 2005). Government incentives meant to encourage VC investment in Greentech must be structured to discourage rent-seeking behavior, not to mandate inflexible solutions, and incent “desirable” investment.

There clearly is a role for the state in encouraging Greentech investment, but the test is in the conceptualization and execution of involvement. In the U.S. context, those advocating government regulations and incentives for Greentech investment may be disappointed in the outcome, which will be shaped by lobbyists for the existing industries. An alternative history would suggest that VC might operate most efficiently in situations where governments made sound macro-level economic decisions such as, for example, a carbon tax and allowed VCs to sort out what they could effectively support. If VC could not operate in such a climate, then it is likely that other financing mechanisms could be substitutes. Angel investors could be substitutes because many are willing to accept higher risks and receive lower returns. In the case of potentially very profitable smaller projects, particularly in the efficiency area, whose potential returns do not justify the attention of full-time VCs, angel investors could provide the necessary funds. Finally, it may be that the Greentech field will require entirely new funding mechanisms.

## Discussion

Given the political economic changes expected to result from global warming and the putative possibility that peak oil has been reached, there should be ample opportunities for innovation and entrepreneurship in Greentech. Though this essay has been skeptical about the general suitability of VC investing in Greentech among U.S. VCs, there is a distinct possibility that there will be interest and opportunities. It is emphatically not a statement that Greentech lacks economic potential, is unnecessary, or even that there may not be a few good deals in the general Greentech area. Many Greentech businesses can grow using self-financing and investments from friends and family. The Danish wind turbine industry is a classic case of such growth. For these firms, there is no need for VC. Greentech will offer many opportunities to existing small and medium-sized firms with strong technical abilities. In many sectors, European and Japanese “mittelstand” firms will have ample opportunity to use their existing knowledge to develop more environmentally friendly products. They will draw upon their existing competences, as did the Danish metal working firms that were early entrants into the wind turbine industry. Finally, one would expect a number of large existing multinationals such as Siemens, Hitachi, Toshiba, Sanyo, and others to be able to leverage their competences to produce Greentech solutions.

If there is a problem with VC investing in Greentech, it is not that value cannot be created in the industry; rather it is because VC is not organized and structured to support most of the opportunities to create value. As we stated, there will be opportunities providing the returns required by VC and which could benefit from VC. Also, it is unlikely that these will create sectors that allow the powerful feedback loops that occurred in IT and biomedical technologies. This most recent spike in Greentech investing is exhibiting the same trajectory as previous spikes.

The collapse of global equity markets and the drop in energy prices has halted the flow of Greentech IPOs. There is little evidence that trade sales of Greentech firms promise to be lucrative.

The current retreat of VC investment is not the first. There have been at least two previous alternative energy/environment VC investment bubbles. The first one in the early 1980s had a few successful exits, but when the Oil Crisis subsided, investment collapsed. The next significant Greentech Bubble was during the Internet Bubble of the late 1990s.

Wüstenhagen and Teppo (2006) identified four Greentech firms that benefited from the wild valuations of the period and went public experiencing excellent returns for investors. However, like so many firms of this period, within three years they had lost nearly all of their value. Significantly, there were few other Greentech IPOs as the VC industry drew back after the excesses of the Internet Era. But in contrast to Greentech firms, some of the Internet Bubble firms, such as Amazon, eBay, and Yahoo! survived and changed our world. Each of the previous Greentech investment surges has proven to be a bubble that, when popped, left little in the way of a new industry or excellent firms that could form the basis for the next surge of interest in Greentech.

This brings us to the contemporary wave of Greentech venture investing, which has been the largest ever. It is impossible to be certain that VC investing in Greentech will continue, or even if the investments already made will survive the suddenly far harsher economic environment of the global economic downturn. Our doubts do not concern the importance of Greentech, but whether VC can provide the financial backing necessary to develop new products and services. There may be some green technologies to which the VC model may be well adapted. Often these are related to industries with a tradition of VC investing such as the

development of software to manage energy usage, creating energy conscious websites, providing lower-energy consumption electronic components and equipment, and data center management protocols. There also may be interesting opportunities in technology-intensive, energy-efficiency products and a myriad of other areas. Often such firms may not have the potential to grow sufficiently large for an IPO, but may make excellent candidates for trade sales.

One area of substantial entrepreneurial opportunity is in the provision of environmentally friendly products to the giant energy economies of China and India. In China demand for Greentech products are driven by the national government that understands the dimension of the nation's problems. Also, in these nations technical and manufacturing labor costs are sufficiently low that small VC investments could yield large returns. It may be that the most interesting opportunities for VC investment would occur in industries and applications regarding improved efficiency and producing the same products at far less cost, even though these are less glamorous than fuel cells, photovoltaics, electric cars, and biomass conversion

VC investors in Greentech will need to identify business opportunities that are not at risk from proximate incumbents and entrepreneurs able to wisely utilize the high powered capital they invest. The challenge of finding potential market opportunities of sufficient size to provide significant growth and exit opportunities may prove more difficult than many believe. The hype that drove Greentech capital raising and investing from 2006 to mid 2008 is being replaced by the sobering problem of finding firms that can reasonably and rapidly become self-supporting, as constant infusions of VC support are no longer possible due to the changing market for exits.

This admittedly skeptical perspective on Greentech for VC investment is not shared by many. For example, a 2009 survey of global VCs concluded that “a majority of venture

capitalists (79 percent) anticipate stable levels of investment across all industry sectors with the exception of the clean technology sector where 63 percent of venture capitalists expect to increase their investments over the next three years (Deloitte 2009: 7).” Deloitte (2009: 8) opined that this increase could be due to “an increase in government/political support for Greentech and VCs are looking more to government participation in both investments and incentives.” Dependence upon government support to make investment decisions financially successful is a dangerous strategy.

Greentech investment has been closely correlated with the price of energy and it is uncertain if this linkage will end. Given the highly volatile history of energy prices, investing in Greentech can be treacherous if the VC investor’s timing is less than ideal, because when the investment matures it may be difficult to sell the company due to a weak stock market. Expecting VC to play a central role in the commercialization of Greentech is unlikely to yield the results that environmental advocates hope. There is a distinct possibility that well-meaning pension funds and endowments seeking to “change the world” with their beneficiaries’ funds may lose their investment in VC firms and not have contributed to environmental improvement. Previous efforts to use VC investing for economic development or other well-meaning causes have often resulted in punishing losses with little advancement of the cause de jour.

## REFERENCES

Akins, James E. Akins. 1973. "The Oil Crisis: This Time the Wolf Is Here." *Foreign Affairs* 51, (3): 462-490.

Associated Press. 2006. "Venture Capitalist Taps Green Technology." April 12.  
<http://www.msnbc.msn.com/id/12281625/>.

Barger, T. 2002. "Issues in Private Equity Funds." Private Equity and Investment Funds, International Finance Corporation (September 14, 2002).

Baum, J. A. C. and Silverman, B. S. 2004. "Picking winners or building them? Alliance, Intellectual, and Human Capital as Selection Criteria in Venture Financing and Performance of Biotechnology Startups." *Journal of Business Venturing* 19 (3): 411-436.

Burg, U. von and Kenney, M. 2000. "There at the Beginning: Venture Capital and the Creation of the Local Area Networking Industry." *Research Policy* 29 (9): 1135-1155.

Bürer, M.J. and Wüstenhagen, R. (2009): Which renewable energy policy is a venture capitalist's best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, 37 (12), 4997-5006.

Bürer, M. J. and Wüstenhagen, R. 2008. "Cleantech Venture Investors and Energy Policy Risk: An Exploratory Analysis of Regulatory Risk Management Strategies." In Wüstenhagen, R., Hamschmidt, J., Sharma, S., and Starik, M. (Eds.) *Sustainable Innovation and Entrepreneurship* Edward Elgar Publishing, pp. 290-309.

Deloitte. 2009. Global Trends In Venture Capital: 2009 Global Report  
[http://www.deloitte.com/dtt/cda/doc/content/us\\_tmt\\_2009vcreport\\_060809.pdf](http://www.deloitte.com/dtt/cda/doc/content/us_tmt_2009vcreport_060809.pdf)

Ernst & Young. 2009. *From Survival to Growth: Global Venture Capital Insights and Trends Report 2009*.

Garud, R. and Karnøe, P. 2003. "Bricolage Versus Breakthrough: Distributed and Embedded Agency in Technology Entrepreneurship." *Research Policy* 32: 277-300.

Gompers, P. A. and Lerner, J. 2001. *The Money of Invention* Cambridge: Harvard Business School Press.

Gompers, P. and Lerner, J. 1999. *The Venture Capital Cycle*, MIT Press, Cambridge, MA.

Helm, D. 2002 "A critique of renewables policy in the UK." *Energy Policy* 30 3:185-188.

Hockerts, K. and Wüstenhagen, R. 2009. "Greening Goliaths versus Emerging Davids – Theorizing about the Role of Incumbents and New Entrants in Sustainable Entrepreneurship." *Journal of Business Venturing*.

Hsu, D. and Kenney, M. 2005. "Organizing Venture Capital: The Rise and Demise of American Research & Development Corporation, 1946-1973." *Industrial and Corporate Change* 14: 579-616.

Kaplan, S. N. and A. Schoar. 2005. "Private Equity Performance: Returns, Persistence, and Capital Flows." *The Journal of Finance*, 60, (4): 1791-1823

Kenney, M. 2003. "The Growth and Development of the Internet in the United States." B. Kogut (Ed.) *The Global Internet Economy* (Cambridge: MIT Press): 69-108.

KPCB. 2008. "Kleiner Perkins Caufield & Byers Launches Green Growth Fund." May 1. [http://www.kpcb.com/news/articles/2008\\_05\\_00.html](http://www.kpcb.com/news/articles/2008_05_00.html) (accessed July 10, 2009).

Milunovich, S. 2009. "Cleantech Collapse: The Horrible Outlook For Alternative Energy In 2009." <http://www.businessinsider.com/cleantech-thus-far-2009-7>.

Pack, H. and Westphal, L.E., 1986. Industrial strategy and technological change: theory versus reality. *Journal of Development Economics* 22 1, pp. 87–128.

Pisano, G. P. 2006. "Can Science be a Business? Lessons From Biotech." *Harvard Business Review* 84 (10): 114-24.

Powell, W. W. et al. 2002 "The Spatial Clustering of Science and Capital: Accounting for Biotech Firm – Venture Capital Relationships" *Regional Studies*. 36 (3):291–305.

Tanzer, M. 1974. *The Energy Crisis: World Struggle for Power and Wealth* (NY: Monthly Review Press).

Teppo, T. and Wüstenhagen, R. (2009): Why Corporate Venture Capital Funds Fail - Evidence from the European Energy Industry, *World Review of Entrepreneurship, Management and Sustainable Development*, 5 (4), forthcoming.

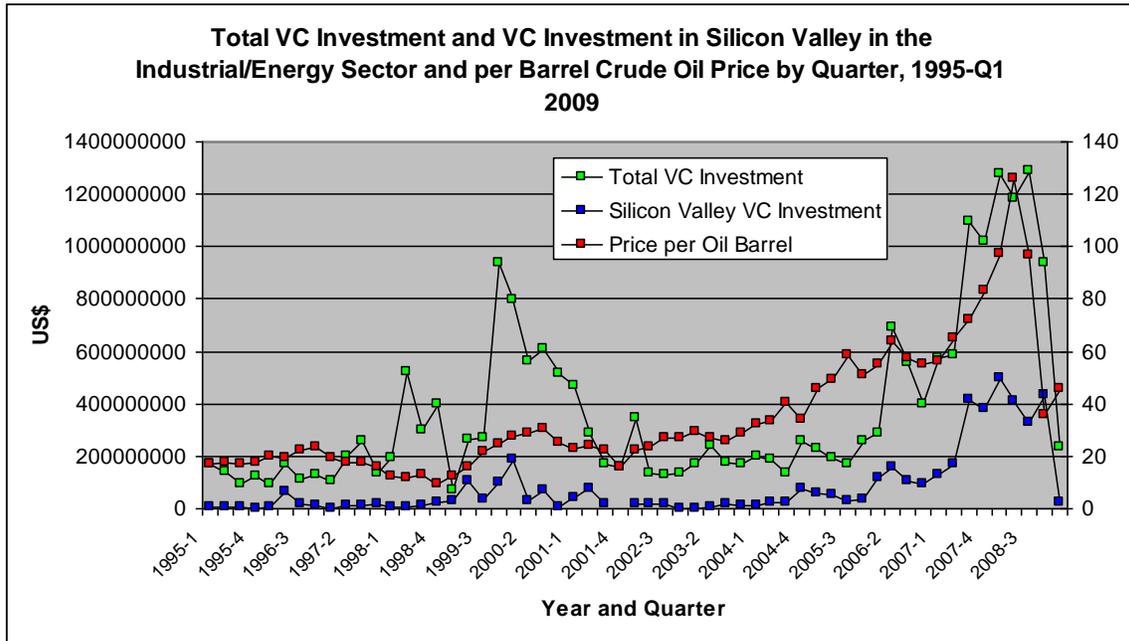
Wuebker, R. 2009. "Unearthing Cleantech: U.S. and Canadian Venture Capital Investments into Cleantech Companies Between 1999 and 2005." Unpublished Manuscript.

Wüstenhagen, R. and Teppo, T. 2006. "Do Venture Capitalists Really Invest in Good Industries? Risk-return Perceptions and Path Dependence in the Emerging European Energy VC Market." *International Journal of Technology Management* 34, (1-2).

Wüstenhagen, R., Wuebker, R., Bürer, M.J., Goddard, D. (2009): Financing fuel cell market development: Exploring the role of expectation dynamics in venture capital investment, in: Pogutz, S., Russo, A., Migliavacca, P. (eds.): *Innovation, Markets, and Sustainable Energy: The Challenge of Hydrogen and Fuel Cells*, Edward Elgar: Cheltenham (UK) and Lyme (US), pp. 118-137.

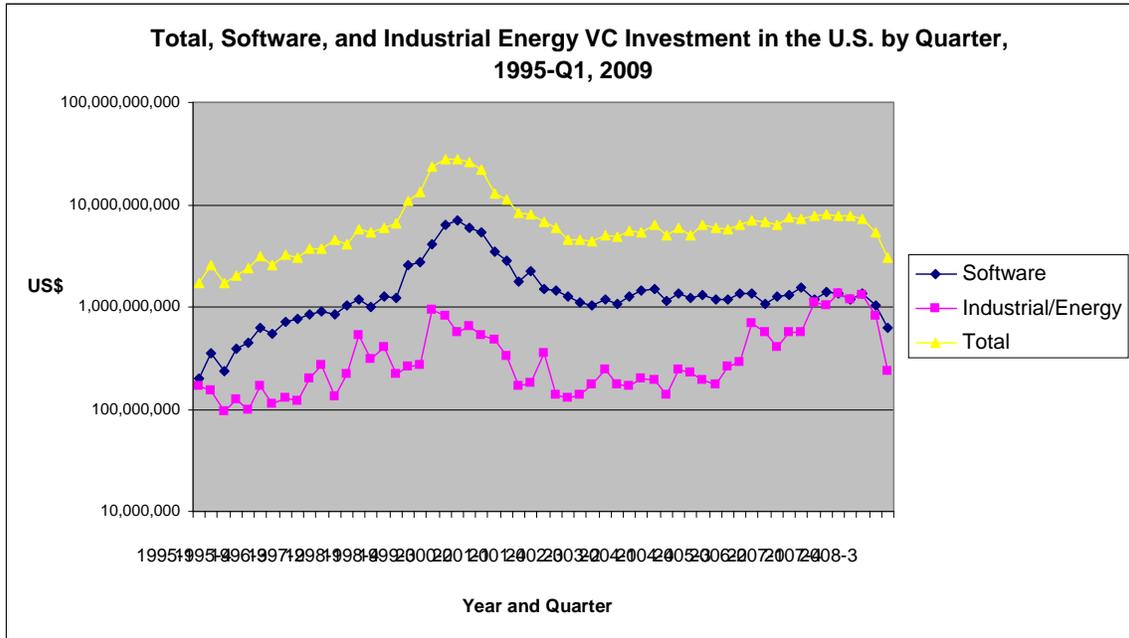
Zook, M.A. 2005. *The Geography of the Internet Industry: Venture Capital, Dot-coms and Local Knowledge*. (Blackwell Publishers).

Figure One



Source: Compiled by author from Pricewaterhouse Coopers Moneytree and U.S. Energy Information Agency

Figure Two



Source: PricewaterhouseCoopers Moneytree