Energy Venture Capital: The New Wave[1]

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The energy industry has recently caught the attention of the venture capital community in a way that hasn't been experienced since the bubble of interest in late 1999 and 2000. With concerns about high gasoline and heating oil prices, the debate about peak oil, and the ongoing threat of global warming, mainline venture funds are now considering the possibility that there is money to be made in the energy technology and systems business.

Energy technology is lately being wrapped in the broader Clean Tech mantel and the enthusiasm for deals in this space is reflected in the numerous conferences and venture fairs that are focused on Clean Tech deals.

Although interest in the energy technology component of the Clean Tech space is certainly running high, it is probably worth sounding a note of caution—although the energy industry is addressing a huge, growing, and transforming market, there are unique and difficult challenges facing investors entering the space. Very few investors have made money investing in energy technology for a simple reason—it invariably takes a great deal of capital (usually well over $100M) and an exceptionally long time (often well over 10 years) to bring a new energy technology to market and reach profitability. And as a result, many ventures that start out on an optimistic note never make it to the goal line.

To provide some perspective on challenges energy tech venture investors face, it is useful to:

- Look briefly at the history of investing in this space;
- Address specifically some of the characteristics of the energy industry that make successful energy tech investing difficult;

- And finally, point to some reasons why there are indeed large opportunities for knowledgeable investors going forward.

A Short History of Energy Venture Capital

Prior to the "Energy Crisis" of the 1970's, energy technology was largely the purview of very large vendors to the major players in the industry. Companies as diverse as GE, Westinghouse, Siemens, ABB, Bechtel, Babcock & Wilcox/McDermott, Fluor Daniel, and Chicago Bridge & Iron built products and systems to serve the growth needs of a very entrenched group of energy suppliers, in four sectors:

- <u>Oil</u>: The "seven sisters" (large integrated companies with world wide reach) and a large number of lower tier players all providing petroleum-based products to a very fragmented group of distribution channels.

- <u>Coal</u>: A few large mining companies and a large number of (often poorly capitalized) small businesses, producing coal from surface and deep mines, shipping it largely by rail, to large industrial and utility customers.

- <u>Electricity</u>: A large number of investor-owned, regulated utilities, as well as municipal utilities and rural electric cooperatives. Each serves—with a few exceptions such as American Electric Power (AEP)—a limited geographic region, and three customer classes: residential, commercial, and industrial, each with distinct needs and requirements.

- <u>Natural Gas</u>: A large number of small producers, as well as the oil majors, supplying gas to a small group of major pipelines regulated by FERC, which in turn supply the gas directly to a limited number of large industrial customers and to state-regulated local distribution companies, principally based in high density metropolitan areas where the cost of laying pipe to serve customers was economically feasible. A few very large gas companies integrate production, pipeline transportation, and distribution under a single corporate umbrella.

In this historical environment, new technology was developed and introduced slowly, usually after many years of testing to insure that it worked flawlessly and was indeed economic. In a number of cases (e.g. nuclear power and gas turbines), the initial development of the technology was done by governments for (largely) military reasons.

Following the 1973 energy crisis, public attention was focused on the energy industry as it never had been before, and the U.S. government set up new (or restructured) energy agencies (the DOE, FERC, and the NRC) to conduct energy research and consolidate regulatory initiatives at the Federal level. During the '70's, the DOE began to conduct research on a variety of Alternative Energy (AE) initiatives, including: solar, wind, fuel cells, synfuels, and energy efficiency. Many of the major energy system vendors began to tap into the DOE funding to pursue AE developments of their own. A few (e.g. Exxon, with its Exxon Enterprises, now dissolved) set out to explore a wide range of energy technologies on their own initiative. Interestingly, this early surge of interest in AE produced almost no venture backed deals—largely because the venture industry itself was in its infancy and such funds as existed at the time focused on markets with apparently more rapid return (computers, semiconductors).

The '70s also saw the formation of industry-sponsored R&D consortia such as the Electric Power Research Institute (EPRI) and the Gas Research Institute (GRI), which tackled the long range technology priorities of their respective segments of the energy industry.

By the mid '80s. energy prices had again dropped to pre-embargo levels (in real terms) and the public's concern about energy issues had waned. Programs on AE continued at the DOE and the industry institutes, but with a much lower sense of urgency. During this period, a few foresighted electric and gas utilities were beginning to see that emerging electronic and AE technologies might give them a competitive advantage in the years ahead, and the first dedicated energy venture fund (the Utech Fund, managed by Aretê Corporation) was formed in 1985 with a group of U.S. and European utilities as limited partners. Although a few deals in the energy space had been done in the '80s by traditional venture funds with an interest in industrial technologies, there was really no focus on the space until Utech began looking specifically for deals in energy, and then cajoling traditional funds into joining syndicates. At least one important technological breakthrough, the discovery of high temperature superconductivity (HTSC) by scientists at the IBM/Zurich lab, led to a flurry of interest in new energy applications and a number of HTSC deals were born and funded by the venture community in 1987-1990, among them:

- American Superconductor (AMSC)
- Superconductor Technologies (SCON)
- Conductus (now part of SCON)
- Illinois Superconductor
- Superconductivity, Inc. (acquired by AMSC)

Also during the late '80s, a few interesting opportunities emerged in other AE fields and venture deals were capitalized in:

- Fuel cells (e.g. Ballard Power/BLDP)
- Solar power (e.g. AstroPower, now owned by GE)
- Automated metering (e.g. Metricom, Domestic Automation)

Although many of these deals made money for their investors, the AE space was still not really on the venture capital radar screen as the '80s closed because most funds were finding exciting opportunities in other fields (computers, software, telecom).

By the early '90s, there were a few new dedicated energy funds beginning to test the market. The flow of interesting energy deals began to increase as efforts to deregulate the utility industry gathered steam and there was a move toward opening up these markets to competition. The more enthusiastic proponents of energy tech investing began to draw parallels with the surge of investment activity in telecom after that industry was deregulated. Still, until the internet bubble pulled almost all investment categories along with it in 1999-2000, the going was often difficult for energy deals. It began to be clear to investors that technology development times were long and that the costs of developing and proving an energy product/system in the field were very high, and raising capital to keep companies going was quite difficult.

Finally the tide turned when Plug Power (PLUG)—a fuel cell company that had massive corporate support—went public in late 1999 and saw its stock rocket on web news, much as many internet and telecom stocks did in that period. In the first nine months of 2000, a number of venture-backed energy tech companies were able to launch successful IPO's, including:

- Capstone Turbine (CPST) —a microturbine manufacturer
- Proton Energy systems (now DESC) —a producer of hydrogen (H2) systems
- Evergreen Solar (ESLR) —a solar photovoltaics (PV) module manufacturer
- Hydrogenics (HYGS) —a fuel cell and test station manufacturer
- Beacon Power (BCON) —flywheel manufacturer

Their prices surged, as did those of companies like AMSC which were already public, and then, when the bubble burst, they all experienced dramatic decline in market cap. Even the scare of the California Energy Crisis in the summer of 2001, which temporarily forestalled the value decline of the public energy tech stocks, did not keep the reality of the challenges facing these companies from becoming clear to the market. Even to this day (early 2006), none of the energy technology companies that went public in 2000 or before have made money—though a few like ESLR and DESC are clearly well on their way to doing so.

Now in the middle years of the first decade of the new century, there is renewed interest in energy technology and traditional venture funds are entering the space as they never did in the past. Why is that?

The Energy Tech Market Today

Clearly the public has once again become acutely aware that energy supply at low prices is not guaranteed and there has been renewed interest in Alternative Energy solutions to what is perceived as a new energy crisis.

- Oil prices have risen to levels (in real dollar terms) in excess of where they were in the oil shock of 1979 when gas lines were a frustrating reality, and the price for gasoline at the pump and heating oil in the tank has hit the average consumer hard in the wallet. It is important to recall that energy prices have followed a cyclical pattern historically and they may again.

- Natural gas prices have also risen sharply, to historically high levels, and that is creating real economic pain for those heating with gas.

- Coal prices have also nearly tripled and, although consumers do not see this directly, it will filter through to them in rising electricity prices and the cost of industrial products.

- There has been a lot of public discussion about the "peak oil" issue—but no real clarity about the real timing of the peak and how declining oil supply will really affect us. For example, if the efficiency (i.e. mpg) of vehicles were doubled, which is certainly doable without a technology breakthrough, though likely at some cost to the customer, would that ease the demand for oil sufficiently to stretch the supply for several decades? The answer is almost certainly yes.

- There is ever increasing evidence that the carbon content in the atmosphere is reaching dangerous levels (Figure 1) and the market has come to understand that AE technologies are certainly part of the solution to reversing, or at least slowing, this trend. But it is clear that much of the world (the U.S. and many of the developing nations, including China) has yet to make a serious commitment to addressing the threat of climate change.

- Largely because of massive government incentives in Germany, Spain, Japan, and recently in California, the solar photovoltaics industry is on a tear. Several very rich public offerings with strong aftermarket support, at least so far, have made it clear that investing in PV companies can be profitable. In time, as manufacturing scale increases and the cost of installed PV drops to the $1-2/watt range, these emerging solar companies may be able to operate profitably without government incentives. Today they cannot.

- In times of high energy prices, innovations in energy efficiency have a very high premium, so there will clearly be an incentive to pursue deals which offer customers savings on their energy costs or shelter from fluctuations in energy prices.

- The public press has given a lot of visibility to demonstrations of hydrogen powered fuel cell vehicles and to the various programs (in California, British Columbia, Toronto) introducing "hydrogen highways" and "hydrogen villages." Most major automakers have announced development initiatives, some of them quite aggressive, to introduce hydrogen fueled vehicles, but the projected introduction dates for those vehicles seem to slip year by year. Nonetheless there is a clear expectation in the marketplace that, in time, a transition to pollution-free hydrogen vehicles will occur.

Although none of these factors is really "new" news (with the exception of higher oil and gas prices, prompted in large measure by the impact of Hurricane Katrina), the confluence of all of them in the recent past has certainly put the spotlight on Alternative Energy and no doubt prompted the interest in AE investments by traditional venture funds. At one level this new found interest is very positive—it means that quality deals will likely have less difficulty raising capital than they did in the past. At another level it is a problem—too many investors looking at too few deals may drive prices to unrealistic levels and lead ultimately to disappointing returns.

The Challenges of Energy Tech Investing

Achieving attractive venture returns in the energy tech field has never been easy—most of the funds involved today are too new to the field to be able to know whether they will make money. Those funds that have been around awhile have found the going pretty difficult and most have not made money, at least not yet. What is the reason for that? There are a number.

First, energy is a commodity. Most users do not care how the product they buy (gasoline, electricity, heating oil) is produced—the only thing that matters to them is price and reliability of supply. Certain users of electricity do care about power quality—voltage instability can wreck havoc with sensitive electronics—and they may be willing to pay more for higher quality. And some customers have demonstrated a willingness to pay a premium for electricity that is produced using "green" technology. But for most users, price is it. It is very hard in the energy business to differentiate products and to provide features and benefits for which the customer will pay more. As a result, new energy technologies must enter the market competing head to head with established cost-effective delivery systems.

Furthermore, the companies that own and operate the existing infrastructure may not be particularly interested in displacing their investment with something new unless they are worried that the "new thing" will steal market share on the basis of price.

To make matters worse, in the regulated part of the energy industry—electric and gas utilities specifically—there is little incentive to take risk on new technologies. Sticking one's head up to advocate a new concept risks getting your head shot off (figuratively) by the regulator if the new concept or technology fails to deliver the expected benefits to the customer. When it appeared that utilities were headed for widespread deregulation and a more competitive market environment, entrepreneurs and venture capitalists were encouraged. But many of the deregulation/competition experiments were not particularly successful and most utilities are now arguing vigorously again for the comforting shelter of regulation. Unless the regulator is pushing new ideas (as in the case of the California PUC's recent solar initiative or Germany's feed-in tariff for PV), it is difficult for new technology to gain a foothold in the regulated utility world.

Small scale, distributed generation of electricity (DG) clearly has attractive benefits in terms of insuring reliability of power in a world where grid stability is at risk under certain conditions (e.g. the Northeast blackout) and, potentially, as a result of terrorist activity. Yet many utilities still vigorously resist customers installing DG systems and impose onerous interconnect standards and punitive back-up power charges. As a result, economically attractive technical solutions, such as efficient micro-turbines providing combined heat and power (CHP) to commercial buildings, are often not pursued by customers, even when they appear to make good economic sense.

In Depth Knowledge of the Space is Critical

Venture firms entering the energy tech space need to add to their teams partners who have deep knowledge of, and experience in, the energy world. This expertise will help insure that concepts that may appear technically intriguing, but are not likely to gain market traction, are avoided as investments. Obviously, one would also expect the management teams in attractive deals to have a clear view of the challenges they face in commercializing their proposed products. But because so few entrepreneurs in the energy tech space have actual hands-on experience in the energy business, it often falls to the venture capitalist to judge the true commercial viability of the entrepreneur's product concept.

Those who have been involved in the energy tech space for a long time often are bemused by the recycling of business ideas that have been around for many years. For example, numerous companies have gone after the automated, remotely-read electric and gas metering market over the years. It is clearly an attractive market, with unit sales potential in the many hundreds of millions, and revenue opportunity in the billions of dollars. But the existing meters installed by utilities are very inexpensive and reading them with a meter reader is not all that costly and is highly reliable. Many ventures have run aground in trying to meet the cost target set by the utilities of less than $100/metering point. As technology advances, new attempts are made, and large-scale tests of various metering products are initiated. But the market entry hurdle for this technology is very high. Most utilities will not place the source of their revenue (the meter read) at risk, and the new metering product must withstand very challenging requirements for accuracy, reliability, and cost. In time, some venture will succeed in the automated metering space, but their success will rest on the bones of many deals that did not make it. Any venture investor new to the energy tech world and intrigued by the idea of automating the meter reading process would be well advised to study what has gone before, prior to jumping in.

A similar concern arises in solar photovoltaics. There are lots of new deals emerging, many claiming to have new and better ways of depositing thin films of photoactive semiconductors on substrates in high-speed roll-to-roll processes. The technical and process challenges in thin-film PV production are very high indeed, and many companies have worked for decades on their processes without notable success. In time, one or more companies will finally succeed in creating a robust thin-film PV production process with high yield—no doubt after spending many years at it and having consumed more than $100M of investors' capital. But before investing in the latest entrepreneur's dream, it would be helpful for the venture capitalist to know about all the deals that have gone before and failed. Then at least he or she will have some sense of the magnitude of the challenge ahead and not be overly surprised if the going gets difficult. [See the case study on Evergreen Solar, Inc. in the box.]

These kinds of challenges are not unique to energy technology. For example, optical signal switching or so-called wave division multiplexing (WDM) had eluded the most talented technical teams in the telecom world for a long time. General Instruments, for example, had spent a bundle of money and many years on the problem before giving up. Still committed, the team from General Instruments went out on its own to raise venture money—a lot of it —and eventually succeeded. The venture-backed company they formed, Ciena Corporation (CIEN), was one of the great hits of the telecom bubble, but the time and price tag to get to the goal were large. In energy technology, that is the case virtually every time.

The Future of Energy Ventures

It's always risky to predict where a field will lead over a long period, but in the case of energy, it seems pretty clear that major changes lie ahead—and that will produce exciting opportunities for venture investors who have patience and deep pockets. Here is why:

- First, we have to solve the global warming problem or we will be in for a pretty grim century. Doing so will produce major paradigm shifts in the way the current energy system works. These upheavals will not be easy, but in the end they will create whole new high tech industries. Some of the energy players dominant today will respond effectively; others will wither and die.

- Second, we will have to kick the oil habit, mostly because of the contribution of oil to the great warming, but also because of supply constraints and the unwillingness of world economies to depend on resources from unstable parts of the world. The emerging economies, China and India in particular, have an opportunity to avoid going down traditional energy pathways, much as many emerging nations have avoided the need for a wires-based telecom infrastructure.

Our prediction on where the energy system will head, as a result of these market forces and others, involves some major changes:

- Renewables will come to dominate the energy supply infrastructure. In particular, solar PV will play a major role as installed costs drop to the $1-2/watt range with increasing manufacturing scale. The emergence of PV as a critical energy supply technology will result from world-wide efforts to reduce global warming. There are very few options that can meet this immense challenge. Solar PV is the most attractive of those options. The challenge is truly enormous. For the atmosphere To remain carbon neutral by 2050 (that is no worse than today's carbon levels), the world will need to add 15-20 terrawatts of new energy supply. That's the equivalent of installing a large 1000 MW power plant somewhere in the world every day between now and 2050. Today, the entire solar industry world-wide is only about 1000 MW (or 1GW) per year. So the PV industry must grow by several hundred fold by 2050 if it is going to make a serious contribution to reducing carbon emissions. There will be lots of business opportunity over the decades ahead if this happens—which it very likely will.

- Hydrogen will become the principal fuel for all transportation and industrial applications. The transition away from carbon-based liquids and gases may take many decades, but it will occur. Initially hydrogen will be produced by steam reforming of methane and perhaps coal, and very likely bio-ethanol and coal-based methanol (in China particularly). In time it will be produced by electrolysis of water using renewable electricity. There will be huge investment opportunities in new technologies for producing, storing, and using hydrogen (i.e. fuel cells). We have barely scratched the surface in these technologies.

- Vehicles will be profoundly different from today. We already see some vision of this change in the "fly-by-wire" and "skateboard" platforms introduced by the major automakers at recent shows. The family car will be made with light weight materials, have very low drag and running resistance, and achieve efficiency levels almost unthinkable by today's standards (perhaps as much as 1,000 mpg).

- "Smart grid" technology will be installed, making the transmission and distribution of electricity responsive to shifting loads, resistant to shocks such as a terrorist attack, and widely supported by highly efficient distributed resources at substations and load centers.

- Home energy systems, such as those already envisioned by Honda, will be widely installed. They will generate hydrogen fuel for the customer's vehicles and home power needs, largely from renewables via electrolysis or direct photo-production. These systems will also augment the grid when they have excess capacity.

- Portable electronic devices will be powered by new devices that combine novel miniature fuel cells, perhaps integrated directly into chips and fueled with alcohols or hydrogen. These new portable power systems will leap frog over even lithium-ion battery technology to provide the volumetric and gravimetric energy density needed to increase the functionality of portable electronic devices and will provide much longer run time than is possible today.

These shifts in the way the energy world works—and likely others which we cannot yet see clearly—will create extraordinary opportunity for energy tech entrepreneurs, and the venture capitalists that invest in their companies. But none of these changes, or paradigm shifts, will likely occur quickly—certainly not at the pace we have become accustomed to in telecom and consumer electronics. So investors in this space must continue to be prepared to invest more and wait longer for their return than they may be used to in other fields. The good news is that, because the energy markets are so immense, the returns for successful deals will be substantial and worth the added risk.

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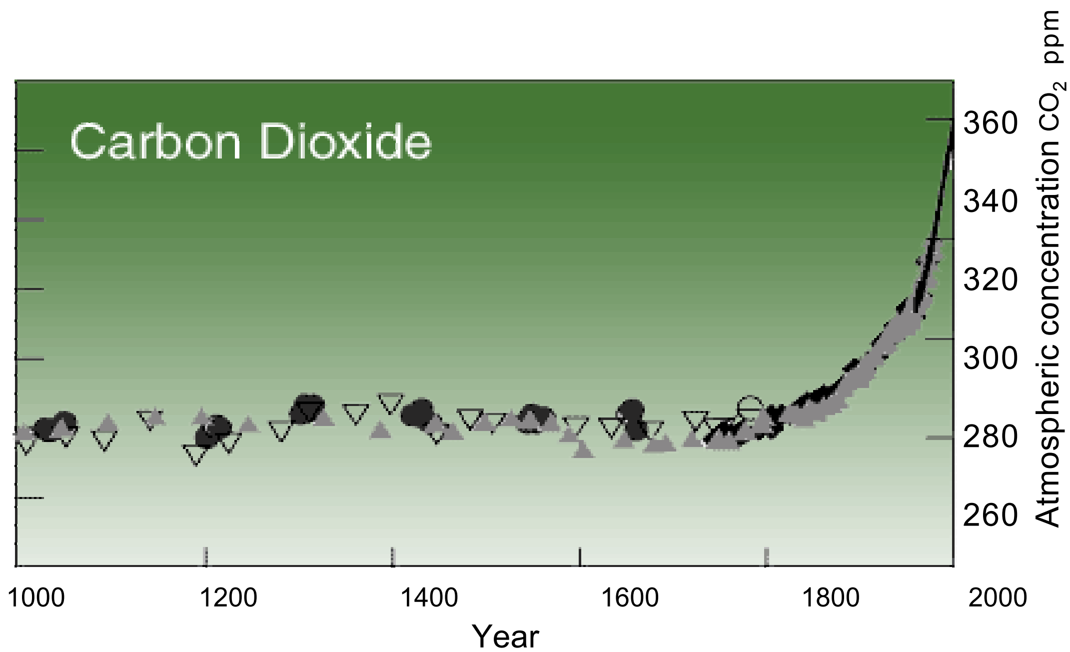
Figure 1. Carbon in the atmosphere has increased to historically unprecedented levels.

Source: IPCC Third Assessment Report (2001)



Evergreen Solar, Inc. (ESLR)

A Case Study

Evergreen Solar was formed late in 1994 by a team of entrepreneurs from the former Mobil Solar. The company was seeded by the Utech Funds and opened its doors in (literally) a garage in Waltham, MA, on the famous "Route 128 corridor." The company's original plan stated that it would refine the already existing String Ribbon Process for producing polycrystalline silicon wafers, which would then be processed into photovoltaic cells and modules using novel approaches that the team had developed. That early plan anticipated that the company would be profitable in three years with a 2MW production facility.

A Series A Preferred round of $2.1M at $1/share was closed in mid-1995, with the seed bridge plus interest converting into the round. The pre-money value for that round was set at a very modest (by today's standards) $2M. Over the next five years, three more rounds of venture financing were raised, each at a modest step-up in value. Over that period, the company worked diligently to perfect its manufacturing process, addressing one challenge after another as it strove to bring yield (and hence, product cost) to acceptable levels for commercial success. The thought of a small, profitable production facility was not any longer in the plan by 1996.

Evergreen was able to complete an IPO in 2000, getting into the market just before the window closed tight in November. Even with the IPO proceeds, Evergreen was not able to perfect and expand its manufacturing process quickly enough to reach profitability, and in 2003 it had to go back to the market (this time the private market again) to raise capital in a PIPE. The price was very punitive, but the company was able to continue its work.

Several more large financings at increasing prices were raised over the last few years (see Figure 2) and today Evergreen has a full 15MW production facility in Marlborough, MA, and is building a new 30MW plant jointly with Q-Cells in Germany. Evergreen has now raised over $275M in its first 11 years and, although it is still not profitable, it is now clearly on its way to becoming a large, profitable producer of photovoltaic power modules. Recently the market price of ESLR exceeded $12.50/share.

Evergreen is a great energy tech success story, but it also clearly illustrates the central theme of energy tech investing—it takes a lot of capital and a long time to achieve a successful and sustainable business in the AE space.

Figure 2. Evergreen Solar, Inc. (ESLR) financing history.

FINANCING	SECURITY	AMOUNT (millions)	YEAR	PRICE / SHARE $
Series A	Convertible Preferred	$ 2.1	1995	2.16 (1.00)
Series B	Convertible Preferred	$ 4.2	1996	3.24 (1.50)
Series C	Convertible Preferred	$ 6.8	1998	4.32 (2.00)
Series D	Convertible Preferred	$ 18.4	1999	5.41 (2.50)
IPO	Common	$ 42.0	2000	14.00
PIPE	Convertible Preferred	$ 29.5	2003	1.12
PIPE	Common	$ 20.0	2004	2.90
Secondary	Common	$ 62.5	2005	5.00
PIPE	Convertible Subordinated	$ 90.0	2005	<7.39>
TOTAL		**$ 275.5**		

( )Pre-split price
< > Convert price