EPA and the Venture Capital Community: Building Bridges to Commercialize Technology

April 2008

SUBCOMMITTEE ON ENVIRONMENTAL TECHNOLOGY

National Advisory Council for Environmental Policy and Technology (NACEPT)

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Subcommittee Members

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Chairman's Prologue

In this third report of the Subcommittee on Environmental Technology, we offer our most challenging—but most promising—recommendations.

In our second report, we recommended that the U.S. Environmental Protection Agency (EPA) work with the private sector to find ways to increase investment in the commercialization of environmental technologies. For this study, we went to the investment community to discover what they think EPA should do to stimulate the development and commercialization of technologies essential for addressing today's environmental challenges. In this third report, we offer recommendations for both EPA and the investment community.

Stimulating private-sector investment in new technologies is among the most important initiatives EPA can undertake particularly with ongoing budget constraints. The global need for solutions exceeds the fiscal capacity of any government, and the commercial market may be able to mobilize and invest immense resources of private capital to develop and diffuse technologies rapidly.

Not long ago, the United States unquestionably dominated the marketplace of new environmental ideas and technology solutions as our nation recognized and addressed threats to health and the environment and vowed to address them through regulations and new technology. EPA embarked on impressive research and development programs—opening laboratories, funding university research, and conducting pilot programs and demonstration programs. Responding to the immediacy of EPA's vision of a cleaner, safer, healthier world, students flocked to universities to study environmental science and to participate in EPA-funded research. As we observed in our previous reports, that era has passed. Since then, EPA has been forced to reduce or discontinue many successful programs that produced significant environmental improvements, and as a result, our nation has lost some of its technical excellence and environmental leadership.

It is time for EPA to restore its powerful vision of a clean and healthy world, by declaring an even more energetic and visionary commitment to technology discovery and verification, and the commercialization of innovative approaches to address threats to health and the environment. Such a commitment is essential to solve the enormous environmental challenges posed by climate change, releases of carbon dioxide and greenhouse gases, the impacts of diminishing resources, nanotechnology and new products, and other issues.

On the positive side, there has never been a better time to act! The global community is increasingly aware of environmental risks and the interconnectedness of our world. Global commerce places companies in many locations around the world and people experience the world more than ever through the media and extensive personal travel. Science is providing explanations of the risks that threaten natural resources, sources of energy and food, human health, economics, and our quality of life.

These challenges call for technological solutions on a scale that requires enormous capital investment. The capital must come from private businesses, individuals, and public institutions with the vision and confidence that technology solutions can succeed. We learned from the investment community that there is

a large amount of capital to be invested in environmental technologies, but the returns on these investments must be comparable to other investment options. To unleash the power of their capital, EPA must ensure predictability and certainty with regard to regulations and enforcement, and dedicate the Agency and its state partners to streamlined permitting. The investment community is impeded not only by EPA regulations, but also by EPA inaction. Indeed, the investors interviewed in this study voiced agreement that uncertainty and the lack of a predictable regulatory framework for carbon dioxide emissions, for example, is retarding investment in these technologies.

It is important to note that the investors do not seek relaxation of regulations, but rather a predictable and consistent regulatory framework that helps define the market and reduce risks of uncertainty. Investors are looking to EPA to consistently enforce regulations to ensure a "level playing field" for all participating companies. After a technology is demonstrated, investors seek a streamlined permitting process that allows prompt market entry. EPA can work collaboratively with states and regional offices to streamline the permitting process for these new technologies. The Agency also can help reduce risks by providing objective technology verifications. All of these actions by EPA will help stimulate new investment by reducing risks.

Investment in the clean energy sector is strong because future market demand is apparent. Energy and environmental technologies often are related, so many new technologies in the clean energy market sector have significant environmental components. For example, technologies that bridge energy and environmental sectors often address challenges related to climate change and diminishing natural resources that threaten human health and the environment. It is logical for EPA to partner with other agencies such as the Department of Energy and seek ways to collaboratively support investment in mutually beneficial technologies.

EPA should initiate better communications with the investment community to promote understanding and mutually beneficial relationships. This is not a simple task. Maintaining a dialogue with the investment community will require fundamental cultural changes at all levels within the Agency, and a clear vision for EPA's role in encouraging environmental technology investments. Our study found that EPA has not been perceived by the venture capital community as open to or interested in such a dialogue. The investment community believes that a constructive dialogue will change that misperception, if it is accompanied by the actions we recommend to EPA.

Investors indicated their willingness to pursue an ongoing dialogue with EPA, and emphasized the need to act now. EPA's interest in initiating such a dialogue conveys an encouraging message. The Agency already has taken important initial steps toward establishing this useful dialogue by appointing a Senior Environmental Technology Officer and establishing Environmental Technology Advocates in each EPA regional office to serve as Agency points of contact, but the vision must be defined and embraced by the EPA Administrator.

We urge EPA to build on this new foundation and capitalize on its scientific and technical credibility by acting promptly on the recommendations in our

report. A visionary goal to preserve human health and the environment for the planet in which we live warrants a sustained commitment to stimulate investment in new technology that rivals the race to space! Acting now is essential to create a new legacy of effective environmental technology solutions.

Philip Helgerson, Chairman
Subcommittee on Environmental Technology
National Advisory Council for Environmental Policy and Technology

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I. Executive Summary

Venture capital investors report that there is a growing interest in environmental technologies, spurred by awareness of global issues such as climate change, as well as the diminishing sources, high costs, and environmental consequences of carbon-based energy, and the increasing costs and decreasing availability of other essential resources such as clean water.

Significant investments are being made by the venture capital community in clean energy-related technologies, including "cross-over" technologies that yield both energy and environmental benefits. Although the growth potential for most environmental sectors is expected to continue to rise through 2010, the most substantial growth is expected in the clean energy sector. Investors have indicated that there is a vast amount of capital available for investing in promising environmental technologies and many individual and institutional investors are seeking opportunities to invest in the growing environmental technology sector. Returns on these investments, however, still must compete with other investment options. Therefore, it is critical to investors that areas of investment risk—often based on regulatory uncertainty and unpredictability—be identified and reduced.

Horizons for investment contemplate long-term potential for the technology, and a predictable forecast of the regulatory environment is essential to reduce uncertainty. Moreover, the new challenges that will be solved by emerging technologies often require a new regulatory framework. Delays in establishing that regulatory framework impede investment in new technology by perpetuating the risk of an uncertain, unpredictable market.

For these reasons, effective stimulation and adoption of new technology requires timely regulatory action. EPA must act promptly to accelerate its engagement with new technology developers and investors, and commit to a credible, long-term advocacy of new technology. This includes not just clear, timely regulations and predictable, consistent enforcement, but also an institutional culture that advocates new technology and stimulates constructive interaction and communication among EPA, technology investors, technology developers, and users.

Findings and Recommendations

Major Findings

Based on the nine interviews conducted and the experiences of the Work Group members, the major findings of the study follow:

1. The existence of regulations many times stimulates technology investment and the lack of regulations can sometimes retard technology investment.

Therefore, regulation of carbon and climate change-related pollutants is needed to advance investment in new technologies to address climate change issues.

2. The early-stage venture capital community is interested in having direct, routine communications with EPA managers and staff (e.g., the Senior Environmental Technology Officer (SETO) and Regional Technology Advocates (RTAs)) and technology developers on environmental technology issues of mutual interest.

3. As became evident when EPA's programs were organized along the continuum developed in the first Subcommittee report, EPA has few programs that focus on the commercialization stage. This stage is critical because many technologies are not commercialized when they cannot bridge the "Valley of Death" (i.e., the particularly challenging period from prototype and proof of concept to the critical later stages of development and profitable revenues).

4. The role of the regulatory community is important in clean technology development and commercialization. Early-stage investors are looking for a minimum of 3 to 5 years of certainty regarding investments contingent on governmental influences. Next-stage investors provide capitalization for taking these new clean technologies to commercial scale. During this commercialization phase, streamlined permitting and consistent enforcement become increasingly important.

5. Investors expect that regulatory requirements will be aggressively enforced so that a "level playing field" for all participating companies will exist.

6. Although venture capitalists have invested in clean technology companies, investors are concerned that there currently is no system or metrics to monitor these technologies to determine if they are "cleaner" than existing alternatives.

7. EPA credibility is high in the investment community. EPA certifications are recognized internationally and can influence a technology's commercialization potential.

Key Recommendations for EPA

The Subcommittee urges EPA to consider the following six recommendations:

1. **Recognize carbon dioxide, greenhouse gases, and climate change-related pollutants as pollutants that are addressed in Goal 1 of EPA's Strategic Plan (Clean Air and Global Climate Change1) and take priority measures within EPA's authority to establish standards and long-term regulations for these pollutants.**

2. **Forge and sustain communications with the early-stage investment community.**

*"Protect and improve the air so it is healthy to breathe and risks to human health and the environment are reduced. Reduce greenhouse gas intensity by enhancing partnerships with business and other sectors." Goal 1. Clean Air and Global Climate Change. U.S. Environmental Protection Agency. *2006-2011 Strategic Plan: Charting Our Course.* EPA-190-R-06-001. Washington, DC, 2006. Available at http://www.epa.gov/ocfo/plan/plan.htm.

3. **Strengthen financial support (e.g., loan guarantees, grants, revolving loan funds) and reduce regulatory risks for new technology development during the commercialization period.**

4. **ake steps to streamline permitting for commercial scale-up of new, innovative environmental technologies.**

5. **Enforce environmental regulations consistently to clarify needs and avoid uncertainty.**

6. **Support metrics and monitoring of new technologies.**

Key Recommendations for the Venture Capital Community

The venture capital community also should take actions to promote EPA's involvement in the environmental technology sector. The Subcommittee encourages early-stage environmental technology investors to consider the following four recommendations:

1. **Collaborate with EPA to establish metrics and monitoring strategies for new technologies to measure and document demonstrated actual performance of these technologies.**

2. **Participate in environmental technology verification programs and EPA-supported metrics and monitoring programs.**

3. **Encourage communication and interaction among technology developers, investors, and EPA.**

4. **Provide opportunities for EPA to financially support promising new environmental technologies through existing and new financial support programs.**

More detail on these recommendations is presented in *Chapter V: Next Steps—Workgroup Recommendations,* which also includes additional recommendations to further EPA's objectives of stimulating development and commercialization of environmental technologies to protect human health and the environment.

II. Introduction – Work Group and Study Approach

This report is the third report in a series of reports prepared since May 2006 by the Subcommittee on Environmental Technology of the National Advisory Council for Environmental Policy and Technology (NACEPT). The purpose of these reports is to improve the effectiveness of the U.S. Environmental Protection Agency (EPA) at stimulating the development of environmental technologies to achieve the objectives of protecting human health and the environment.

In its first report, *EPA Technology Programs and Intra-Agency Coordination* (May 2006), the Subcommittee presented the "EPA Environmental Research and Development Continuum" as a perspective from which the Agency could view its role in the creation and diffusion of new technologies. In a second report, *EPA Technology Programs: Engaging the Marketplace* (May 2007), the Subcommittee described a recommended external focus for EPA initiatives to be addressed by the Senior Environmental Technology Officer (SETO) and Regional Technology Advocates, and identified the need for EPA to strategically partner with other organizations to develop and commercialize environmental technologies.

This report, *EPA and the Venture Capital Community: Building Bridges to Commercialize Technology,* summarizes the assessments and recommendations of nine leading representatives from the investment community who routinely review and engage in investment opportunities targeting early-stage environmental technologies. Together, they represent a valuable perspective on some key trends that dominate this investment market.

Without exception, the investors share confidence about the current and future business opportunities in the environmental technology market. They have shared their candid assessments about ways EPA influences those opportunities. They also have offered suggestions about steps the Agency can undertake to remove barriers, stimulate technology development, and increase the introduction of new technologies to address persistent and emerging environmental challenges.

A. Origin and Purpose of the Study

In October 2004, U.S. Environmental Protection Agency (EPA) Administrator Michael Leavitt asked the National Advisory Council for Environmental Policy and Technology (NACEPT) to investigate two questions:

- How can EPA better optimize its environmental technology programs to make them more effective?
- What other programs should the Agency undertake to achieve this goal?

NACEPT formed the Subcommittee on Environmental Technology to address this charge and the Subcommittee held its first meeting in November 2004. Since then, NACEPT has endorsed and forwarded to the EPA Administrator two reports by the Subcommittee on Environmental Technology, which are both available on the Web at http://www.epa.gov/etop.

In the first report, *EPA Technology Programs and Intra-Agency Coordination,* the Subcommittee presented the "EPA Environmental Research and Development Continuum" as a perspective from which the Agency could view its role in the creation and diffusion of new technologies. Placing EPA technology development programs on the continuum illustrates that EPA has offered limited programs to support the development of technology during the challenging commercialization phase. As a result, environmental technologies developed by EPA and by others with and without EPA support have largely relied on funding from the private sector to be commercialized and used to protect public health and the environment. The report challenged EPA to adopt a more significant role in technology development as a fundamental part of its activities, and to seek a balance approach that fulfills the need for participation at all stages in the development continuum, with particular emphasis on the gaps in the commercialization phase.

In its second report, *EPA Technology Programs: Engaging the Marketplace,* the Subcommittee described a recommended external focus for EPA initiatives to be addressed by the Senior Environmental Technology Officer (SETO) and Regional Technology Advocates, and identified the need for EPA to strategically partner with other organizations to develop and commercialize environmental technologies. Recommended strategic partnerships would provide opportunities for EPA to stimulate and support increased investment in the commercialization of environmental technologies and build upon the Agency's internationally recognized scientific and technical expertise.

While actively implementing recommendations in the first two reports, EPA's Office of Research and Development requested that NACEPT direct the Subcommittee to extend its efforts by engaging with the investment community and seeking advice on actions that EPA and the investment community could take, and partnerships that the Agency and the investment community could create, to stimulate greater private sector investment for commercialization of environmental technologies over the long-term.

A fitting sequel to its first and second reports, this third effort explores critical components of the early stage investment process, including current investment practices and trends; discusses positive and negative influences of EPA in investment opportunities and decisions from the perspective of those in the investment business; and offers suggestions to remove or overcome barriers and critical gaps and create productive relationships leading to increased investment and commercialization of environmental technology.

B. The Study Work Group

To address this charge, the Subcommittee formed a focused Venture Capital Work Group. The members of the Work Group are listed in **Appendix A** and the Charge to the Work Group is provided in **Appendix B**. The Work Group was asked to conduct a study and prepare a report to be reviewed and approved by the

Subcommittee for submission to the NACEPT Council and subsequent transmission to the EPA Administrator.

To design an approach to engage with the investment community, the Subcommittee invited five highly regarded professionals familiar with early-stage technology investment to join with an equal number of members of the Subcommittee on Environmental Technology to form the Venture Capital Work Group. The Work Group members, listed in the **text box on this page**, identified and recruited potential interviewees from the venture capital community, participated in the interviews, formulated the findings and recommendations in this report, and offered insights from their own experiences with the environmental technology investment community.

C. Study Approach

The overall approach for the Venture Capital Study was to compile and review reports and other information about venture capital investment in environmental technology and to conduct interviews of nine members of the venture capital community whose investments include a clear focus on early-stage environmental technologies.

The Work Group members considered EPA's draft *Venture Capital Support for Environmental Technology: A Resource Guide* (this document was prepared to provide EPA staff an overview of venture capital investment in environmental technology) and other sources of information on investment in environmental technology to develop contextual and background information for this report (see the reference list in **Appendix J**). The combined financial, technical, and investment experience of the members enabled the Work Group to identify leaders in the environmental technology investment community for the interviews. In

Venture Capital Study Work Group Members

Phil Helgerson*, *Work Group Chair*, Computer Sciences Corporation
John Hornback*, Executive Director–Metro 4, Inc. and Southeastern States Air Resource Managers, Inc.
Robin Newmark*, Director–External Relations Global Security Principal Directorate, Lawrence Livermore National Laboratory
Karen Riggs*, Battelle Memorial Institute
Daniel Watts*, *Liaison to NACEPT*, Executive Director Otto H. York Center for Environmental Engineering & Science–New Jersey Institute of Technology
Andrew dePass, Managing Director and Head of Sustainable Development Investments for Citi Alternative Investments
Bryan Martel, Managing Partner–Environmental Capital Group LLC
Frank McGrew, Managing Director–Morgan Joseph & Company, Inc.
John Preston, Senior Lecturer–Massachusetts Institute of Technology Entrepreneurship Center
John Wise, *Liaison from the EPA Environmental Financial Advisory Board (EFAB)*

* NACEPT Subcommittee on Environmental Technology Member

addition to being leaders in the venture capital community, a number of the interviewees had substantial knowledge of and experience with EPA and its technology programs, making them particularly qualified to participate in this study.

The Work Group designed a comprehensive interview approach, described in more detail in *Section E. Interview Process,* which posed meaningful questions to the interviewees that evoked thoughtful observations, advice, and recommendations for EPA and the venture capital community. The Work Group members reviewed the background materials and analyzed the interview discussions to develop the findings and recommendations presented in this report.

D. Venture Capital Community Interviewees

The Work Group thoughtfully selected nine leading venture capital investors and advisors whose collective investments make up a substantial portion of the venture capital investment in environmental technology, particularly early-stage investment. Without exception, these individuals are recognized, influential leaders in the environmental investment community. Together, the portfolios of the firms represented by the individuals selected for interviews total more than $3 billion. The investment community leaders who volunteered to share their perspectives and suggestions as part of this study are identified in the **text box below**.

Venture Capital Study Interviewees

Rob Day, Principal–@Ventures
John DeVillars, Founder and Partner–BlueWave Strategies
Hank Habicht, Managing Partner–SAIL Venture Partners
Winston Hickox, Partner–California Strategies
Kef Kasdin, General Partner–Battelle Ventures
Eric McAfee, Managing Director–Cagan McAfee Capital Partners
Chuck McDermott, General Partner–RockPort Capital Partners
William Reilly, Founding Partner–Aqua International Partners/ Texas Pacific Group
Rosemary Ripley, Member–NGEN Partners

Not surprisingly, several of the leading environmental technology investors gained their specialized awareness of the technical and regulatory aspects of environmental technology opportunities through significant roles in the environmental regulatory community. Some served in public positions, including a former EPA Administrator, a former EPA Deputy Administrator, a former EPA Regional Administrator, and a former Secretary of California's Environmental Protection Agency. As a result, the interviews reflect a strong awareness of EPA's past and present policies, procedures, and programs. Biographies of the interviewees are provided in **Appendix C**.

Chapter IV: Findings from the Interviews with the Venture Capital Community, presents the ideas, concerns, and suggestions offered by these venture capital community representatives, but to ensure an open dialogue in the interviews the report does not attribute specific comments to any of the interviewees.

E. Interview Process

The Work Group identified a list of potential interviewees and selected nine highly qualified representatives of the venture capital community based on the following criteria:

- EPA-Related Experience
  - Portfolio includes environmental technology investments.
  - Evidence of actively seeking environmental technology investments (e.g., attending and speaking at environmental conferences)
  - Portfolio of environmental technologies is not limited to energy-related technologies (renewables, sustainable).
  - Level of sophistication about markets (does not just follow others investing in the latest "hot topic").

- Investment Experience
  - Experience with traditional (or new) environmental technology and not just energy technology.
  - Experience with early stage investment.
  - Experience with seed/first round funding.
  - Minimum of 5 years of experience as a senior venture capitalist.
  - Experience managing funds of $20 million to $200 million.
  - Experience managing funds other than hedge funds.

The Work Group decided to focus on early stage investors and not to include institutional or social investors. In addition, the Work Group agreed to consider angel investors only if they are bringing opportunities to first-round investors.

Twenty-one venture capitalists were identified and considered by the Work Group. The list was narrowed to 13 of the most qualified individuals based on the selection criteria. These 13 potential interviewees were contacted to determine their willingness and availability to be interviewed. Although everyone contacted about participating in the study indicated their interest in the topic, some were not available for an interview during the short timeframe in which they were to be conducted. Nine of the individuals contacted confirmed that they were willing and available to participate in the study interviews and the telephone interviews were scheduled for the month of February.

The Work Group designed a Pre-Interview Instrument, provided in **Appendix D**, which was sent by e-mail to the interviewees 1 to 3 days before the interview. The interviewees were asked to complete the pre-interview instrument rating questions and submit them to the Work Group prior to the interview. This allowed the Work Group time to tailor the open-ended questions posed during the interview and to probe deeper on specific areas of interest.

The Pre-Interview Instrument described the background and purpose of the study as well as the process for the interview, and provided instructions on completing and returning the instrument to the Work Group. The Pre-Interview Instrument was divided into four parts: (1) Current Investment Practices, (2) Future Investment Outlook, (3) EPA Activities, and (4) Open-Ended Questions. The interviewee was instructed to complete and return the first three sections prior to the interview, which involved assigning ratings. The 10 open-ended questions (**see text box on page 10**) were provided prior to the interview to give the interviewee

an idea of the types of questions that would be posed during the telephone interview.

The Work Group conducted all nine interviews during February 2008. The interviews consisted of discussion of the rating responses from the Pre-Interview Instrument and the 10 open-ended questions and sub-questions, tailored somewhat to each interviewee. These questions are provided in **Appendix E**.

As expected, a range of responses to the pre-interview questionnaire provided a stimulating background for the open-ended questions which were discussed during interviews. The range of rating responses to the questions posed in the Pre-Interview Instrument is illustrated in **Appendix F**. Interviewees also were asked to provide examples of successful environmental technology investments during the interviews and these are referred to throughout this report and described in **Appendix G**.

The Work Group analyzed the Pre-Interview Instrument responses and interview discussion summary transcripts as well as other background materials to develop the findings and recommendations presented in this report. To foster an open and frank discussion, this report relates the assessments and comments of the interviewees without attribution or individual quotations. The Work Group has framed the results of the interviews with a set of concrete findings and achievable recommendations. To ensure that the information and responses provided by the venture capital community were presented accurately, each interviewee was asked to review and comment on the draft report. Their comments were incorporated into the final version of the report.

The Ten Open-Ended Questions Used in the Interviews with Venture Capitalists

1. What are the most important metrics used by your firm in evaluating environmental technology investments?
2. What is driving environmental technology investment—EPA activities or private-sector activities or both?
3. Do you think environmental technologies have a more difficult entry and/or exit investment strategy than other clean technologies? If so, what can be done to make it easier?
4. Are there characteristics of environmental technologies and markets that need to change to attract venture investment?
5. Which environmental technology segments (e.g., climate change, water technologies, etc.) have the greatest potential to generate investments in the next few years?
6. Are there "cross-over" opportunities for certain technologies to support both environmental technology and energy technologies?
7. What can EPA do to reduce the environmental technology investment risks?
8. What EPA activities present significant barriers to environmental technology investment?
9. Are there some successful technology development and commercialization programs that EPA can learn from? If so, what are the programs?
10. How can EPA continue a dialogue with the investment community in the future?

III. Venture Capital Setting

A. Definitions

Venture Capital and Venture Capital Fund

Venture capital is a type of private equity capital typically provided by professional, outside investors to new, high-growth businesses. Generally made as cash in exchange for shares in the portfolio company, venture capital investments usually offer the potential for above-average returns. A venture capital fund is a pooled investment vehicle (often a limited partnership) that primarily invests the financial capital of third-party investors in enterprises that are too risky for the standard capital markets or bank loans. Venture capital typically is associated with new, cash poor, and/or rapidly expanding companies. Venture capital managers often are actively involved in the management of the expanding companies in which they invest. In return for the capital invested, venture capitalists receive equity shares and privileges, such as active participation in the company's management and profit sharing.

Environmental Technology

Traditionally, the environmental technology sector has been viewed as a diverse range of equipment, services, and resources. There have been a number of definitions for this sector, one such definition was given in the 1995 report "Bridge to a Sustainable Future: National Environmental Technology Strategy" (see references in **Appendix J**), in which it was defined as:

> "A technology that reduces human and ecological risks, enhances cost effectiveness, improves process efficiency, and creates products and processes that are environmentally beneficial or benign. The word 'technology' is intended to include hardware, software, systems, and services. Categories of environmental technologies include those that avoid environmental harm, control existing problems, remediate or restore past damage, and monitor and assess the state of the environment." (National Science and Technology Council, 1995)

Over the past 12 years, the definition of environmental technology has changed. In 2007, the Department of Commerce, International Trade Administration (ITA), defined the environmental technologies industry as goods and services that advance sustainable development by reducing risk, enhancing cost effectiveness, improving process efficiency, and creating products and processes that are environmentally beneficial or benign. The environmental technologies sector includes: air, water, and soil pollution control; solid and toxic waste management; site remediation; and environmental monitoring and recy-

cling. ITA found that the environmental technologies sector is comprised of the four major categories:

- Monitoring and Assessment—Technologies used to establish and monitor the condition of the environment.
- Pollution Avoidance—Equipment and processes used to prevent or minimize the generation of pollutants.
- Pollution Control—Technologies that render hazardous substances harmless before they enter the environment.
- Remediation and Restoration—Technologies used to render hazardous substances harmless.

According to the ITA, water equipment and chemicals, and air pollution control represent the largest percentage of the U.S. environmental technologies equipment market; wastewater treatment and solid waste management represent the largest percentage of the U.S. environmental technologies services market; water utilities and resource recovery represent the largest portion of U.S. environmental technologies resources market (U.S. Department of Commerce International Trade Administration, 2007).

Clean Technology

Many investors believe that clean technology is an investment theme or category. The definition used by the venture capitalists interviewed in this study is that cleantech is any knowledge-based product or service that improves operational performance, productivity, or efficiency, while reducing cost, inputs, energy consumption, waste, or pollution. Cleantech advocates view the metamorphosis of the environmental technologies industry or sector into the Cleantech Sector much as many environmentalists view sustainability as the new form of environmental protection. This new view of environmental technologies has been adopted and promoted by Environmental Entrepreneurs (E2), an affiliate of the Natural Resources Defense Council (NRDC), one of the largest environmental advocacy organizations in the nation.

The Cleantech Group (formerly the Cleantech Venture Network), a coalition of nearly 20,000 cleantech investors, companies and professional service organizations, categorizes cleantech investments into 11 segments:

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

The Cleantech Group (http://www.cleantech.com) is a membership organization of cleantech investors, companies, and professional services organizations with assets exceeding $6 trillion. (The Cleantech Group includes venture capital

firms, investment banks, limited partners, governments, and major corporations with offices in North America, Europe, China, and India.)

Beyond traditional environmental technologies such as air and environment, recycling and waste treatment, and water and wastewater, several cleantech segments also include environmentally related technologies such as agriculture (e.g., farm efficiency technologies, natural pesticides), materials (e.g., green chemistry, nanomaterials, and environmentally friendly solvents), and transportation (e.g., hybrid vehicle technology, efficient engines).

In a May 2007 report, "Cleantech Venture Capital: How Public Policy Has Stimulated Private Investment," E2 and the Cleantech Group state that cleantech categories encompass a broad range of products and services, from alternative energy generation to wastewater treatment to more resource-efficient industrial processes. Although several of these categories are 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: (1) optimize use of natural resources, offering a cleaner or less wasteful alternative to traditional products and services; (2) have their genesis in an innovative or novel technology or application; and (3) add economic value compared to traditional alternatives" (Stack, et al., 2007).

B. Trends In Venture Capital Funding

The United States maintains the oldest and most dominant position worldwide in venture capital. In 2006, U.S. venture capitalists invested $25.5 billion in 3,416 deals (i.e., companies), realizing a 10 percent increase in deal volume and a 12 percent increase in dollar value compared to 2005. In 2005, venture capital investments worldwide reached $31.3 billion (U.S. dollars). The United States, Canada, Europe, and Israel represent 93 percent of capital invested, while China and India account for the remainder (Deloitte & Touche, 2007).

Generally, U.S. venture capital investing has recovered from the collapse of the internet investment bubble in 1999-2001. Venture capital investment peaked in 2000 with over $100 billion placed in deals at various stages. In August 2007, the National Venture Capital Association reported that 14 of the 17 industry sectors tracked by the association, including the industrial/energy sector, experienced an increase in the number of deals for the second quarter of 2007 (National Venture Capital Association and PricewaterhouseCoopers, 2007).

C. Environmental Technology Investment Market

Significant investments are being made by the venture capital community in clean energy-related technologies, including "cross-over" technologies that yield both energy and environmental benefits. Although the growth potential for most environmental sectors is expected to continue to rise through 2010, the most substantial growth is expected in the clean energy sector. Investors have indicated that there is a vast amount of capital available for investing in promising environmental technologies and many individual and institutional investors are seeking opportunities to invest in the growing environmental technology sector. Returns on these investments, however, still must compete with other investment options.

Therefore, it is critical to investors that areas of investment risk—often based on regulatory uncertainty and unpredictability—be identified and reduced.

In 1995, the Interagency Environmental Technologies Office (IETO), a federal agency group created to enhance technology collaboration and reduce barriers, found that financial uncertainty and a high level of risk limit the availability of investment capital for environmental technologies. Although the environmental technologies industry at that time was larger than many other sectors of the U.S. economy, the IETO found it attracted very little private capital. In 1993, the IETO pointed out that approximately $31 million in venture capital was invested in conventional control and remediation technologies supporting just 12 firms. In 1994, this amount dropped to $25 million invested in fewer than 10 companies and was projected to continue to decline. The IETO concluded that a number of reasons accounted for the environmental technology industry's tendency to repel capital. Government environmental policies and regulations were important drivers of the market but the timing and size of current and future markets often was a function of the specifics of regulation, including the timetable for new regulations, the stringency of current standards, and their enforcement (National Science and Technology Council, 1995).

Today, there are more optimistic data about environmental technologies but the investment levels are small compared to energy technologies. The cleantech category currently offers a good approximation for venture capital support for environmental technologies. Although the cleantech category is dominated by four energy segments (i.e., energy generation, energy infrastructure, energy storage, and energy efficiency) and energy-related investments have led other segments for the past 2 years, there has been some encouraging growth in some environmental technologies segments. U.S. and Canada investments in environmental technologies, such as recycling and waste and transportation (i.e., hybrid vehicles), also showed gains since 2005. Investments in energy-related technologies totaled $2.14 billion, almost three times the amount invested in 2005, and 33 percent greater than the investment total for the entire cleantech industry in 2005 (Stack, et al., 2007).

In 2006, cleantech became the third largest U.S. and Canada venture capital investment category (11 percent of all venture investments), behind software and biotechnology. In 2006, total U.S. and Canada venture capital invested in cleantech companies reached $2.9 billion, a 78 percent increase over the $1.6 billion invested in 2005 (Stack, et al., 2007).

Since the economic downturn of 2000-2001, cleantech is one of the few U.S. categories that has experienced real growth in venture investments. While U.S. venture capital investments as a whole were down by 33 percent in 2006 compared to 2001, investments in U.S. cleantech companies were up 243 percent in that time (Stack, et al., 2007).

In the second quarter of 2007, the cleantech sector was the third largest industrial sector based on venture capital investments, totaled $451 million going into 44 deals. This represented a 38 percent increase in the number of deals and a 46 percent increase in dollars, attributed to a $73 million investment in a solar energy company, the largest deal of the quarter (National Venture Capital Association and PricewaterhouseCoopers, 2007).

D. Opportunities for Increasing Investments in Environmental and Clean Technologies

The "environmental marketplace" where technologies are deployed consists of several distinct sectors based on the physical resources addressed (e.g., water, air, land), services delivered (supply) and structure of consumption (demand). The growth potential for most environmental sectors is expected to continue to rise through 2010. As depicted in **Table 1**, economic activity is categorized in three broad sectors—Services, Equipment, and Resources—based primarily on the type of firms selling in each sector and what is sold, as well as the common purchasing patterns within those sectors.

Table 1. Environmental Industry Sector Growth 1990-2000 and 2000-2010 ($ in billions)

Environmental Industry Sectors	2000	1990-2000 *Growth*	2010	2000-2010 *Growth*
Services				
Analytical Services	$1.6	-26%	1.9	19%
Wastewater Treatment Works	$30.0	34%	44.5	48%
Solid Waste Management	$42.0	45%	58.8	40%
Hazardous Waste Management	$8.0	-15%	9.7	21%
Remediation/Industrial Services	$10.0	5%	13.7	37%
Consulting & Engineering	$18.0	21%	28.8	60%
Equipment				
Water Equipment and Chemicals	$20.0	57%	32.6	63%
Instruments & Information Systems	$4.0	84%	6.0	50%
Air Pollution Control Equipment	$18.0	30%	19.1	6%
Waste Management Equipment	$9.6	20%	11.5	20%
Process & Prevention Technology	$1.2	192%	2.0	67%
Resources				
Water Utilities	$33.0	53%	42.3	28%
Resource Recovery (recycling)	$18.0	29%	25.5	42%
Environmental Energy Sources*	$15.0	87%	38.2	155%
U.S. Totals:	**$228.4**	**35%**	**$334.6**	**46%**

* Environmental Energy Sources (biomass, wind power, landfill gas, solar power, geothermal, mini-hydros, fuel cells) encompasses both system sales and revenues from electricity production. The rough estimates for growth by *Environmental Business Journal* assume current federal and state tax incentives and other measures are renewed or remain in place as legislated.

Several interviewees noted that venture capital firms are investing in new environmental technologies that hold promise for transforming large industrial process operations. Advanced Electron Beam is an example of such an investment. It is a venture capital-supported environmental technology that has "in line" manufacturing process applications (**see description of Advanced Electron Beam on page 16**).

These different markets can, in turn, be plotted by size and growth rate to characterize the nature of opportunities (**see Figure 1**).

Group A in the figure represents small, but high growth market niches—Process, Prevention, and Instrumentation, including "clean energy"—where the growth rate and dynamism helps create larger opportunities for adopting innovative technologies. Venture capitalists express a clear preference for high growth

"Funding New Environmental Technology That Holds Promise for a Cleaner Environment"

Advanced Electron Beam

www.aeb.com

RockPort Capital Partners

Advanced Electron Beam (AEB) in Wilmington, Massachusetts, has developed a breakthrough electron beam technology—the AEB Emitter—that is 10 times less expensive and 100 times more compact in size than conventional electron beam units. While electron beams have historically been used in industrial applications to replace chemical and thermal processes, adoption has been limited because of high equipment and operating costs, complex imple-mentation, and the huge size of conventional electron beam technologies. By contrast, the AEB Emitter makes it possible to integrate this clean energy source into a wide array of applications that was never before technically or economically feasible. AEB Emitters can be aligned in multiples to produce a beam of any desired width and are small enough to be directed at any angle.

AEB Emitters have an operating voltage of 80-150 kV and weigh less than 30 pounds. More-over, the approach requires no active vacuum pumping equipment, offers a compact, solid-state power supply, and requires no in-plant engineering or maintenance expertise. Specific AEB Emitter applications include: the destruction of airborne viruses and bacteria; the extension of shelf life of foods; generation of hydrogen for fuel-cell vehicles; the modification of recycled tires into high-quality engineered plastics; and the removal of hazardous gases, such as sulfur and nitrous oxides (SO_X/NO_X), from fossil-fuel burning power plants.

In March 2007, AEB announced it had received $17.5 million in a Series B funding round led by RockPort Capital Partners, with participation from existing investors Atlas Venture and General Catalyst Partners. The funding will be used to accelerate commercialization of AEB Emitters as one of the world's most efficient, clean, and cost-effective forms of industrial energy.

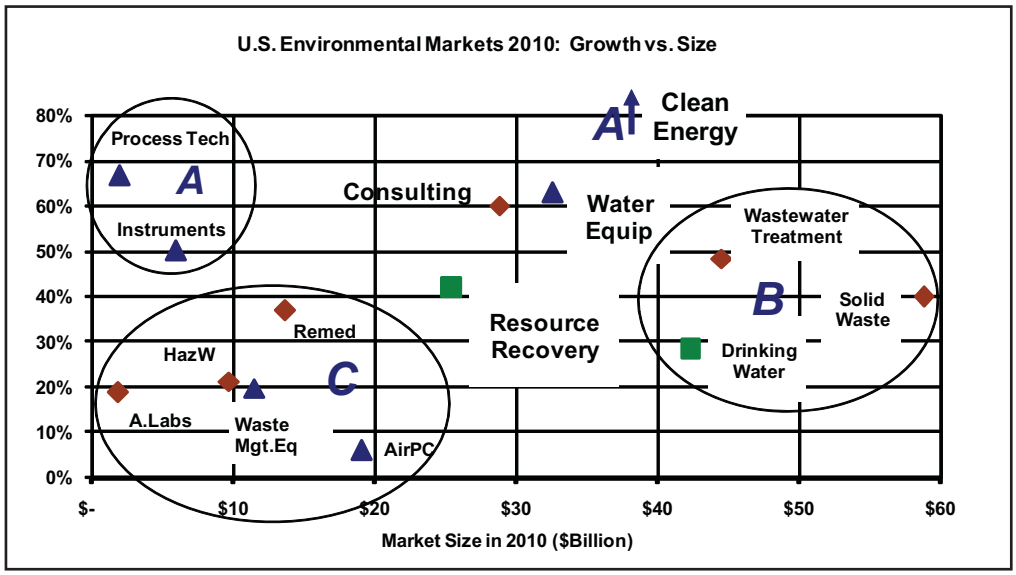
markets. Trends for the clean energy market were recently published in a report by Clean Edge, Inc. (**see text box on page 18**).

Group B represents larger, slower growth markets—Wastewater Treatment, Solid Waste, and Drinking Water, where growth is tied closely to demographic growth and suburban expansion. Technology in these markets often is geared to any change in regulatory standards or enforcement.

Group C represents smaller, "back end" remedial markets—Remediation, Air Pollution Control, Waste Management Equipment, Analytical Labs, and Hazardous Waste—which are not growing as fast as the economy or demographics, and may actually contract in some years (e.g., with recession). Some aspects of these markets are shrinking, such as Superfund and cleanup of underground fuel tanks. Hazardous waste volumes also contracted in the 1990s as industry cleaned up operations. Landfills were not expanded much overall.

Other market niches—Consulting Services, Resource Recovery, and Water Equipment—tend to be driven by the other sectors and regulatory changes. Water equipment could represent an opportunity for innovative technologies if regulatory changes were made, but buyers tend to be risk-averse and compliance oriented, often content to use conventional technologies.

Figure 1. Plot of Market Size vs. Market Growth of Environmental Market Segments



Source: Environmental Business Journal, 2008

E. Stages of Investment

Historically, venture capitalists have invested in the initial stages of a company's development but the size and number of investments were cumbersome and the recent trend is to support companies at a later stage in their development. In general, there are four stages of company development in which venture capital can be invested. These stages are:

- Seed/Startup Stage—the company has a concept or product under development;
- Early Stage—the company has a product or service in testing or pilot production;
- Expansion Stage—the company product or service is in production and commercially available; and
- Later Stage—the company product or service is widely available.

The majority of venture capital investments go to follow-on funding for companies originally financed by angel investors, corporate investors, or government programs. This trend continued in 2007. In early August 2007, it was reported that venture capitalists invested $7.12 billion in 977 deals in the second quarter of 2007—the highest level of investment reported in a quarter since the third quarter 2001. By stage of company development these investments were: Seed/Startup – 3%; Early Stage – 19%; Expansion Stage – 33%; Later Stage – 44% (NVCA and PricewaterhouseCoopers, 2007).

The National Association of Seed and Venture Funds (NASVF) found that venture capitalists primarily invest in those business sectors that are not only growing rapidly but also have not yet reached the competitive shakeout stage. In other words, venture capitalists fill a gap between the early startup stage and later consolidation (NASVF, 2006).

Clean Energy Trends 2008 Report (http://www.cleanedge.com/reports/reports-trends2008.php)

According to *Clean Energy Trends 2008*, produced by Clean Edge (and co-authored by GreenBiz.com executive editor Joel Makower), global clean-energy markets are expanding rapidly and just four sectors—biofuels, wind power, solar photovoltaics, and fuel cells—are projected to more than triple over the next decade, growing to $254.5 billion by 2017. Revenues in these four benchmark sectors increased 40 percent in 2007, up from $55 billion in 2006 to $77.3 billion in 2007. For the first time, three of these sectors are generating revenue in excess of $20 billion apiece, with wind now exceeding $30 billion. New global investments in energy technologies—including venture capital, project finance, public markets, and research and development—have expanded by 60 percent from $92.6 billion in 2006 to $148.4 billion in 2007, according to research firm New Energy Finance.

The report indicates that global production and wholesale pricing of biofuels reached $25.4 billion in 2007 and is projected to hit $81.1 billion by 2017. The global biofuels market last year consisted of more than 13 billion gallons of ethanol and more than 2 billion gallons of biodiesel production worldwide. Wind power is expected to expand from $30.1 billion in 2007 to $83.4 billion in 2017. Last year's global wind power installations reached a record 20,000 megawatts (MW), equivalent in size to 20 conventional fossil-fuel power plants. Clean Edge also found that solar photovoltaics (including modules, system components, and installation), which totaled $20.3 billion last year, will more than triple to $74 billion by 2017. Annual installations in 2007 were just below 3,000 MW worldwide.

New global investments in energy technologies—including venture capital, project finance, public markets, and research and development—have expanded by 60 percent from $92.6 billion in 2006 to $148.4 billion in 2007, according to New Energy Finance. In the United States, venture capitalists invested $2.7 billion in the clean-energy sector, representing almost 10 percent of total venture capital activity.

The Work Group made a decision to focus this study on Early Stage investments both because this is a critical phase in the success of technology development and, given the small number of interviews to be conducted, the Early Stage focus allowed the Work Group to narrow the field of potential interviewees. Although Early Stage investments were the primary focus of the study, the interviewees also described investments at other stages to make certain points. During the course of the interviews, the venture capitalists also provided examples related to investments at earlier and later stages (**see Appendix G**).

IV. Findings from the Interviews with the Venture Capital Community

This section contains findings identified by the Work Group from the nine interviews conducted during the study. These findings are arrayed across the following four subsections:

- Drivers of Environmental Technology Investment
- Regulatory Context
- EPA Role in Technology Development and Commercialization
- Future EPA Interactions with the Investment Community.

A. Drivers of Environmental Technology Investment

The Work Group identified the following findings related to drivers of environmental technology investment:

1. Although venture capitalists have invested in cleantech companies, investors are concerned that there currently is no system or metrics to monitor these technologies to determine if they are "cleaner" than existing alternatives.

2. Environmental investors expect venture grade returns; they are not investing to "save the planet."

3. Municipalities and utilities are the largest customers for environmental technologies and they are a difficult and risk-averse customer set.

4. The role of the regulatory community is important in clean technology development and commercialization.

5. Environmental technologies have a more difficult "exit strategy" than other clean technologies. (Exit strategy is the process through which venture capitalists realize their investment returns through sale or initial public offering.)

6. There is a lack of experienced managerial talent in environmental technology companies.

The decision thresholds for investors to capitalize environmental technology enterprises (i.e., companies or projects) are complex and varied. It was pointed out during the interviews that venture capitalists do not invest in research and development or even in technologies, per se; they invest in commercial enterprises for profit that are promoting innovative technologies under certain regulatory and market conditions and scenarios.

Although venture capitalists have invested in cleantech companies, investors are concerned that there currently is no system or metrics to monitor these technologies to determine if they are "cleaner" than existing alternatives. Interviewees expressed the need to better understand the net environmental benefits of clean energy and other technology investments. The California Public Employees' Retirement System (CalPERS) uses both financial due diligence and environmental due diligence when deciding what investments to make in venture capital firms that want to fund environmental technologies. Environmental Capital Group (ECG) currently performs the environmental due diligence service for CalPERS.

A brief description of the ECG's environmental due diligence process is presented in the **text box on page 21**, and a more complete description of the process is contained in **Appendix H**.

Venture capitalists expect substantial profits over a 5 to 7 year horizon. As many of the interviewees noted, environmental investors expect "venture grade" returns; they are not investing to "save the planet."

The most prevalent drivers identified among interviewees fall into three categories across the spectrum of environmental technologies: (1) metrics—investment criteria for venture funds; (2) policy—federal and state legal and regulatory framework, and legislative outlook; and (3) market factors, including technological obsolescence, customer resistance, etc.

Metrics

A variety of metrics drive the investment decision and these metrics can be characterized as "hard" metrics or "soft" metrics.

Hard metrics are the fundamental criteria for investment decisions, such as:

- Expected rate of return commensurate with risk;
- Break-through technologies with good comparative advantage;
- Market size, penetration, and growth prospects; and
- Economic value proposition based on business plan, management team, and eventual exit strategy for capital return.

Return on investment (ROI) was the metric most often cited by venture capitalists during the interviews. Their belief was that a risk-adjusted ROI is the only measurement that matters in an investment. In other words, a highly profitable opportunity that has high risk and a long time frame is less attractive than a less profitable idea with low risk and a short time frame. Investors cannot know what the ROI will be ahead of time; they only know a projected one. Therefore, other factors are weighed to evaluate the potential for *and* risks to successfully meeting a projected ROI at the time of investment.

Besides ROI, many venture capitalists are concerned whether the technology they are considering is a "breakthrough" technology with a good competitive advantage compared with what is currently available. The cost and technological advantages of a product and/or service need to be clearly demonstrated. Many venture capitalists agreed that the world market for "disruptive" green

"Environmental Due Diligence Process Used by CalPERS"

The California Public Employees' Retirement System (CalPERS) uses both financial due diligence and environmental due diligence when deciding what investments to make in venture capital firms that want to fund environmental technologies. CalPERS uses the Environmental Capital Group (ECG) to perform the environmental due diligence. The purpose of the environmental due diligence is to answer two key questions:

1. If the technologies of the portfolio companies are successfully commercialized, will the fund result in significant net environmental benefits?

2. Does the fund management have the capability and willingness to implement its environmental strategy and measure the resultant environmental benefits?

ECG has developed analytical methods to measure and report significant net environmental benefits created by the portfolio companies. To analyze net environmental benefits, ECG considers how the "new" process or product compares to the "existing" process or product. This requires an understanding of not only the environmental impacts of the company's technology, but also of the technology that it seeks to replace. It also requires establishing the boundaries of the analysis and considering significant positive and negative environmental impacts within those boundaries. The potential sources of environmental benefits relate to consumption of energy and raw materials, manufacture of product and by-products, and product functionality (i.e., the technology may be more environmentally benign than the product it replaces). All five areas—product raw materials, energy raw materials, manufacturing or energy-production process, product functionality, and by-products (emissions)—must be considered in an analysis of net environmental benefits and they usually are linked.

To move from concepts about environmental benefits to specific results for each portfolio company, ECG developed an Environmental Performance Reporting System (EPRS). The objectives of this system are to: (1) measure the net environmental benefits of each fund and portfolio company investment, and (2) establish an environmental performance basis for proactively choosing future clean energy and technology investments. The calculation of net environmental benefits can be thought of as an engineering or technical report that links a business result, such as the number of product units sold or amount of material processed, to the associated environmental result, such as tons of emissions avoided or gallons of water saved. ECG works with the General Partner to conduct this analysis, including assessing which environmental impacts should be included, identifying respected literature sources, and checking the analysis for consistency with similar technologies based on our broad understanding of the market. In some cases, the analysis is reviewed with an expert in the appropriate field.

At the end of each fiscal year, the General Partner collects business results data from each portfolio company and calculates the associated net environmental benefits using the analysis framework established at the time of investment. ECG collects and reviews this information and works with the General Partner to update and refine the analysis framework.

technologies was good. The potential market size, the anticipated penetration into the market, and the short-term growth potential for the technology and service were viewed as significant determinants for driving investor decisions.

For environmental technologies, most investors were concerned about the potential customers. Traditionally, municipalities and utilities are the largest customers for environmental technologies and investors agreed that they are a difficult and risk-averse customer set. In using new environmental technologies, municipalities and utilities are concerned about the uncertainty of the technology and the financial strength of the supplier company's balance sheet. Based on these concerns, most investors evaluate products for these customers by asking two questions: "What change in application or performance does this technology present?" and "What is the capability of the management team to get the technology to market?"

"Economic value propositions"—a company's business model, its management team, and the eventual exit strategy for the investment—were considered important for any environmental technology or clean technology investment. Unfortunately, the venture capitalists found a lack of experienced managerial talent in environmental technology companies and that most environmental technologies have a more difficult exit strategy than other clean technologies in the energy sector.

Soft metrics are considerations often employed by public pension funds, foundations, and public institutions for environmental and other clean technology investments. They include:

- Investment transparency that withstands public scrutiny;
- Socially responsible investing;
- Sustainability or reduced environmental and resource impact;
- Good will reputation for investing in companies that have a positive impact on the environment; and
- Patient capital for longer term environmental improvements.

Because of their nature, public pension funds and their investment decisions are likely to be held up to public scrutiny and require more "transparency" in their investments. These funds may be especially concerned about the public's reaction to losses on investments with which the public is unfamiliar such as high-risk venture capital investments. They also may require evidence of satisfactory investment performance on a more regular basis.

Socially responsible investing describes an investment strategy that combines the intentions to maximize both financial return and social good. In general, socially responsible investors favor company practices that are environmentally responsible, support workplace diversity, and increase product safety and quality.

The desire to "do well by doing good" is common to both sustainable investing and socially responsible investing. The key difference between the two approaches is that sustainable investors tend to give more weight and attention to environmental issues than socially responsible investing. Sustainability or reduced environmental and resource impacts are secondary considerations for many investors. Many pension funds, foundations, and public institutions, however, prefer sustainable investments that have beneficial environmental and economic results.

Some venture capital firms are creating a "good will" reputation for investing. These firms offer high economic returns with a reputation for investing in companies that will have a positive impact on the environment. Most sustainable investment opportunities, for example, normally are believed to exist only in exciting young companies that focus on organic food or alternative energy production; these good will firms, however, invest in "old economy" industry companies, such as autos and oil, which are transforming themselves.

Patient capital—funding from investors who do not expect immediate returns on their investments—is becoming more popular for some clean technology investments. Beyond the financial ROI, there are externalities associated with environmental investing. How much energy is saved, how much the carbon foot print is reduced, or how much water is conserved are becoming important externalities in investing. The "universal investor concept" attempts to capture these primary and secondary considerations.

Policy or Legal Framework

The role of the regulatory community is important for clean technology investment. Most investors are scared away from investing in a business that is based on the creation of regulations. They do not want to invest in companies that hope a regulation will drive their market potential. They prefer investing in companies that do a better job meeting existing regulations; this creates a better economic value. Although government regulations are important, venture capitalists do not favor investments in technologies whose future markets could be eliminated with a "stroke of the pen" (i.e., regulation change). They want to see that the technology provides enough economic value on its own.

The legal framework is comprised of many issues including applicable federal/state regulatory and enforcement regimes, tax policies, subsidy provisions, and other mandates. The regulatory and enforcement regime is an essential primary driver for many investments; whereas, taxes, subsidies, and mandates play important subsidiary roles.

The legal framework is known as "policy risk" in the investment community. To minimize this "policy risk," an investment calculus needs reasonable certainty and stability for the legal framework with dependable terms of application of at least 5 years. Where the legal framework is likely to change (such as new statutes authorizing "cap and trade" markets), clear signals in anticipation of such change are needed. Hence, regulation is not enough to mobilize venture investment; economic value is vital.

Market Factors

Market considerations are an important metric in any investment decision. Nearly all interviewees agreed that the markets for environmental technology are driven by global markets because they comprise the most basic functions of any economy: water treatment and delivery, agriculture and land use, effluents of basic manufacturing and materials processing, air pollution handling, and the instrumentation, design, monitoring, and services of these functions.

New market drivers are emerging that are creating more interest in environmental technologies (i.e., instrumentation, process efficiency) and more sustain-

able energy options, which are driven by higher oil and gas prices, more severe storm and weather damage (e.g., hurricanes, tornados, flooding, extended drought), rapid economic growth in developing countries, and public awareness of resource strains.

Anticipation of new laws and mandates (e.g., legislation on carbon emissions, automobile fleet mileage standards, and water treatment rules for shipping vessels) also is creating expectations for market growth. Climate change considerations, for example, will drive the market for water supply and treatment technologies.

Some interviewees identified market opportunities in "cross-over" technologies. These are technologies that address both environmental and energy issues. One example of such a technology is the use of a wastewater treatment technology to convert a sugar-laden waste stream for the generation of ethanol. Other cross-over technologies that were identified during the interviews included: technologies that save energy through efficiencies, waste-to-energy plants, drought-resistant crops, smart-grid sensors, and more energy efficient water treatment systems.

Although several market niches are growing, others such as Superfund cleanup and underground storage tank remediation, have peaked in activity, and are subsiding. Still, the market and customer base for pollution control/remediation technologies is constrained by the risk-averse nature of municipalities, utilities, and their supporting engineers and consultants. Most interviewees confirmed this view identifying "risk aversion of POTWs (publicly owned treatment works)" as the highest rated market factor in evaluating an investment.

B. Regulatory Context

The findings from the interviews with respect to regulatory context include:

1. The existence of regulations many times stimulates technology investment and the lack of regulations can sometimes retard technology investment. Therefore, regulation of carbon and climate change-related pollutants is needed to advance investment in new technologies to address climate change issues.

2. The role of the regulatory community is important in clean technology development and commercialization. Early-stage investors are looking for a minimum of 3 to 5 years of certainty regarding investments contingent on government influences. Next-stage investors provide capitalization for taking these new technologies to commercial scale. During this commercialization phase, streamlined permitting and consistent enforcement become increasingly important.

3. Investors expect that regulatory requirements will be aggressively enforced so that a "level playing field" for all participating companies will exist.

4. Many EPA regulations prescribe specific control levels. Unfortunately, Best Available Control Technology (BACT) rules and regulations are not written in a way to maximum investor interest.

5. Some of EPA's most successful programs affecting investors are voluntary programs such as Energy Star.

6. Intellectual Property Rights protection is an important issue for investors.

Market conditions and governmental activities have major impacts on the attractiveness of investments in environmental technologies. Actions of the government may include dissemination of information, advocacy, policy-setting, regulation promulgation, promotion of voluntary programs, provision of funding, and offering of other incentives. Environmental technology investments are not made in the absence of clear evidence that such ventures have a high likelihood of success from a market standpoint. Without substantial profit potential, an environmental technology will receive little attention. Even if the technology shows promise, governmental actions and programs can have major influence, both on the final investment decision and the final outcome.

Regulatory Programs

Regulatory programs are of key interest to venture capital firms. Technologies have been spawned by emergence of new and enhanced environmental requirements. Some of these technologies have represented major markets with substantial profit possibilities while others, similarly important, have been much narrower in scope and thus have been less appealing for investment.

Interviewees offered diverse views on the importance of environmental regulation. In some cases, investors reported that they avoid investing in ventures that are driven by, or dependent on, government regulation or regulatory compliance. In other cases, a market may be perceived to have the capacity to flourish because of the existence or promise of a regulation. The degree of opportunity is case-specific and dependent on the perspectives of the investor. Several venture capitalists saw regulations as useful but not sufficient to justify investment. Opinions ranged from investments in companies where there is little regulation (i.e., government-wide regulation, not just EPA) to investments in companies affected by regulation to investments in companies where regulations help create the need for environmental technologies. Regardless of their perspective, most interviewees found that, beyond government regulations, there must be an economic case for the investment as well.

Environmental technologies may be mandated by, or may arise from, two different kinds of regulations. Technology-based regulations specify that certain types of technologies must be installed in specific circumstances and that the operation and maintenance of those devices will constitute compliance with the regulations. Performance-based regulations deal less with modifying behavior and focus more on outcomes. They specify the desired result and give the regulated community more flexibility to determine how to comply in an effective way that achieves the desired end result. Performance-based approaches generally allow the regulated community to comply more efficiently and effectively, taking into consideration the unique circumstances of their particular business. Venture capital firms tend to have a preference towards performance-based regulations.

Many EPA regulations prescribe specific control levels. Unfortunately, such regulations are not written in a way to stimulate keen investor interest. Because

many regulations are worded in a manner that limits flexibility, they do not encourage venture capitalists to invest in companies responding to technology standards.

Regulatory predictability was cited by many interviewees as a necessity to merit a technology investment. For those technologies dependent on government regulation and for those investors interested in such technologies, success is dependent on certainty. Because administrations and legislatures change with regularity, policies are likewise subject to routine change. Most interviewees agreed that venture capitalists want potential government policies "memorialized" in statutes and regulations.

Most investors are looking for a minimum of 3 to 5 years of certainty regarding investments contingent on governmental influences and they prefer even longer horizons where the regulatory requirements are fully known. Further, investors expect that the regulatory requirements will be aggressively enforced so that a "level playing field" for all participating companies will exist.

Regulatory risks are an inherent part of any investment. Venture capitalists assume substantial risks as they become involved in new growth businesses. It is hard for them to understand why government agencies are not willing to assume risks relative to environmental technologies. As new environmental technologies emerge, they must be tested in real-world applications. In many cases, such tests require regulatory agency approval. Traditional regulations, especially those that are technology-based, however, require a degree of certainty that they will successfully achieve their design parameters. In many cases, field-testing is required to confirm hypothesized performance levels. In the most critical environmental programs and for the most promising technologies, interviewees suggested that regulators should find ways to promote field-testing of new technologies so that their capabilities can be established in a timely manner. Doing so would raise the interest level of those with capital to invest in such emerging markets.

Non-Regulatory Practices

In addition to direct regulatory programs and requirements, interviewees found that environmental technology investments can benefit from indirect regulation, voluntary programs, incentives, and general advocacy. Interviewees found that some of EPA's most successful programs affecting investments are voluntary rather than regulatory in nature (e.g., Energy Star).

Indirect Regulation

EPA's Toxics Release Inventory (TRI) is a public database of information on discharges, emissions, and other releases of chemical compounds exhibiting certain toxics characteristics. The TRI has become a database of prime interest to the public, raising concern in the minds of facility owners and the public about actual and potential environmental impacts of releases. Through public scrutiny and much media attention, companies became sensitized to these concerns and voluntarily initiated release reduction plans as well as substitutions of less toxic compounds where possible. Interviewees noted that since it was first introduced, TRI has caused major reductions in releases of toxic compounds without any regulatory mandate to do so. Financial rating agencies have reinforced this trend

based on the public information value or the "black-eye effect" of the TRI disclosures.

Voluntary Programs

EPA has established a number of voluntary programs that have encouraged the development of more environmentally-friendly technologies. The Energy Star Program was initially designed to identify consumer products that conserve energy. Public interest in such products has been high and in the past 15 years the number of Energy Star products has grown substantially. As of 2006, more than 40,000 Energy Star products were available in a wide range of categories, including major appliances, office equipment, lighting, home electronics, and more. In addition, Energy Star labeling can be found on many new homes and commercial and industrial buildings. In 2006, about 12 percent of the new U.S. housing stock was labeled Energy Star compliant.

Incentives

Venture capitalists are interested in technologies with a large potential for market success. Most are only interested in technologies that have a multi-billion dollar market potential because technologies penetrating large markets generally can grow more dramatically. Unfortunately, many niche environmental technology products that may be protective of human health and the environment face less investor interest due to their limited market potential.

Several interviewees cited the value of government activities that can assist with bringing technologies to the marketplace. Examples of such government activities include: tax credits, direct funding (grants and loans), special regulatory provisions such as expedited permitting, and general advocacy.

Protection of Intellectual Property Rights

Intellectual property rights (IPR) protection is an important issue for investors. Several interviewees acknowledged that some technologies within their portfolio companies were created from intellectual property developed in government or academic laboratories. IPR rules of ownership need to be clear, particularly in foreign markets. Mixed IPR ownership discourages investors. Interviewees found that IPR issues for government researchers must be addressed, and if these researchers cannot share in invention royalties, then the government should find some way to address this issue.

Absence of Regulation

Rather than being too regulatory dependent, sometimes the lack of regulations retards technology investment. Many interviewees cited climate change or carbon regulation as a key determinant for lack of investment in this market. If the government is going to mandate some type of carbon controls sometime between 2009 and 2011, investors need to be making those carbon-related investments now. Yet few investors are willing to make such investments with the uncertainty about whether there will be future government regulations in this area and the form that such regulations may take.

C. EPA Role in Technology Development and Commercialization

The findings regarding EPA's role in technology development and commercialization include the following:

1. EPA credibility is high in the investment community. EPA certifications are recognized internationally and can influence a technology's commercialization potential.

2. EPA and other government agencies can have a "positive catalytic effect" in venture capital investments.

3. In the past 2 years, the U.S. DOE Office of Energy Efficiency and Renewable Energy has initiated several successful clean technology development and commercialization programs. There are "cross-over" technologies that have both energy and environmental benefits (e.g., waste-to-energy and carbon sequestration technologies) on which EPA and DOE could collaborate.

4. Some states, such as California and Pennsylvania, and non-profit organizations like Ceres (www.ceres.org)—a coalition of investors and environmentalists for sustainable prosperity—and the New England Clean Energy Council have initiated noteworthy clean technology initiatives.

Environmental Technology Development and Investment through Market Drivers

In addressing the question of what effort(s) might best promote market use or adoption of environmental technologies, interviewees noted the following efforts that could carry the most impact:

- Expedited permitting
- Federal mandates
- Government grants to environmental technology firms
- Federal subsidies for technology performance.

In specifically addressing EPA's role, interviewees also suggested investment in environmental technologies would be enhanced by the following:

- Programs approving specific technologies for emission reductions.

- Grants or other incentives to directly fund a class of technologies.

- Reports of performance (verification or demonstration).

- Rules, regulations, or technical guidance specifying use of selected environmental technologies.

These findings all suggest a need for EPA to establish market drivers for environmental technology development.

Interviewees noted that market mechanisms could be used to address or prioritize environmental technology investments. For example, CalPERS has established a $200 million Environmental Technology Program Board that targets investments in environmental technology solutions that are more efficient and less polluting than existing technologies such as recycling, minimizing the use of natural resources, and reducing emissions, refuse, and contamination to air, water, and land. The primary objective of the Program is to achieve attractive investment returns over the long-term and help catalyze the adoption of environmental and clean technologies to the broader marketplace (**see the description of CalPERS in the text box on page 30**).

EPA and other government agencies can have a "positive catalytic effect" in venture capital investments. Governmental policies and programs that support the deployment of environmental technologies coupled with certainty that these activities will remain in place stabilize the market. Interviewees found, for example, that regulatory certainty is beneficial for both the regulated community and investors. Mandates that last for 3 to 5 years or longer to allow venture firms to amortize their investments enhance the predictability and influence of government activities on new technology markets.

National and International Technology Verification and Certification

Interviewees noted that third-party evaluations are helpful in supporting new technology development, growth, and acceptance in the marketplace. They also indicated that certifications are valuable in foreign markets. EPA certifications are recognized internationally and can influence a technology's export potential. Interviewees noted that foreign interest in reciprocal technology verification programs is strong. Most thought that the Agency needs to push for objective, verified protocols and standards that can be used by all countries.

EPA credibility is high in the investment market. Several interviewees noted that EPA procedures often can validate the performance claims of technology vendors. ORYXE Energy International and WaterHealth International are venture capital portfolio company examples of how EPA procedures helped validate technology developments for a fuel additive and ultraviolet disinfection technology (**see the descriptions of ORYXE Energy International and WaterHealth International on page 31**).

Outside of Federal Government efforts, several interviewees commented on the value that non-governmental certification can provide to investors. Private-sector certification programs such as the LEEDs (Leadership in Energy and Environmental Designs) Green Building Rating System as well as the Forest Stewardship Council and Marine Stewardship Council accreditation services were cited as especially successful.

Federal, State, and Private Programs for Technology Development and Investment

Interviewees mentioned several government and non-government programs that have been created in the past several years that are successfully supporting innovative technology development. "Targeted" federal technology development programs are the most effective ways to stimulate investments. Existing

"Pension Fund Investing in Environmental Technology"

Environmental Technology Program
California Public Employees' Retirement System (CalPERS)
(http://www.calpers.ca.gov)

CalPERS provides retirement and health benefits to approximately 1.5 million public employees, retirees, and their families and more than 2,500 employers. It has a strong track record of mobilizing financial capital in new and innovative ways, consistent with the highest fiduciary standards. Earlier this decade, CalPERS began to explore ways in which it could marry the jet stream of finance and the capital markets with public purpose with the goals of achieving positive financial returns, while fostering energy savings, sustainable growth, and sound environmental practices.

In March 2004, CalPERS launched a new investment program to invest up to $200 million in the burgeoning environmental technology sector during the next few years. The System's Board of Administration approved the CalPERS Environmental Technology Program that will target investments in environmental technology solutions that are more efficient and less polluting than existing technologies such as recycling; minimizing the use of natural resources; and reducing emissions, refuse, and contamination to air, water, and land. CalPERS established the program to capitalize on the evolving investment sector and deliver increased returns to its private equity portfolio.

The primary objective of CalPERS' $200 million Environmental Technology Program is to achieve attractive investment returns over the long-term and help catalyze the adoption of environmental and clean technologies to the broader marketplace. CalPERS is building a "best of breed," diversified portfolio of clean technology-focused investments by investing across stages, strategies, geographies, and structures. The Program defines environmental or clean technologies as solutions that are more efficient and less polluting than existing or legacy products, services, or technologies. Areas of particular interest include alternative and renewable energy (clean energy), water technologies (clean water), advanced materials or nanotechnology (clean material), air purification technologies (clean air), and transitional infrastructure opportunities. It is expected that investment returns in this sector will be commensurate with the risk-adjusted returns of the general private equity market.

CalPERS uses both financial due diligence and environmental due diligence when deciding what investments to make in venture capital firms that want to fund environmental technologies. As of September 30, 2007, CalPERS had committed $200 million to seven investment partners: NGEN , Craton Equity Partners, Carlyle/Riverstone, DFJ Element, RockPort Capital Partners, Vantage Point Venture Partners, and EnerTech Capital.

federal programs cited by interviewees include DOE programs to develop renewable energy sources and photovoltaics and U.S. Department of Defense (DOD) Programs to develop energy storage batteries.

Federal

At the federal level, many interviewees cited DOE's Energy Efficiency and Renewable Energy (EERE) Program and those ongoing at the DOE national laboratories as worthy examples for EPA to investigate. Two highly cited EERE Programs include the Solar America Initiative and the EERE Technology Maturation Funding Program. The Solar America Initiative (SAI) is a DOE effort to accelerate the development of advanced solar energy technologies. The goal is

"Technology Verification Validates Innovative Environmental Technology Claims"

ORYXE Energy International and WaterHealth International

www.oryxe-energy.com
www.waterhealth.com

SAIL Venture Partners

ORYXE Energy and WaterHealth International (WHI), both in Irvine, California, have developed patented environmental technologies that are addressing unique environmental problems. ORYXE Energy has developed a breakthrough additive, ORYXE™ RFT, to improve efficiency and reduce harmful emissions in residual oil-fired boilers and process heaters. WHI developed a low cost, ultraviolet water disinfection device, the UV Waterworks™ (UVW), which was invented to address the needs of underserved communities around the world. Both patented technologies have been subjected to air and water pollution testing procedures developed by EPA to validate their pollutant reductions claims.

Testing has proven that ORYXE RFT provides significant reductions in particulate matter emissions while keeping NOx neutral and improving furnace heat transfer. Residual oil-fired plants experience reduced black smoke emissions from their exhaust stacks and improved overall efficiency with the use of ORYXE RFT. The efficiency improvement often offsets the cost of the additive, thus providing users with an emission reduction program that requires no large capital expense and little to no operational expense.

Dr. Ashok Gadgil, Vice President of Scientific Affairs for WHI, developed UVW at the DOE Lawrence Berkeley National Laboratory. Through a multi-stage filtration process coupled with a proprietary UV disinfection technology, contaminated water is converted into clean, potable water that exceeds the World Health Organization's standards for potable water. The UVW-based system effectively purifies and disinfects water contaminated with a broad range of pathogens, including polio and roto viruses, oocysts, such as *Cryptosporidium* and *Giardia*. Low maintenance requirements, high efficiency, and high throughput make UVW systems capable of delivering affordable, high-quality drinking water even to remote and rural markets that have previously been under served.

ORYXE Energy's new technology already has been proven to reduce emissions in diesel fuel. The technology was used to develop an alternative diesel formulation, approved by the Texas Commission on Environmental Quality, to meet the new Low Emission Diesel standards in Texas. The immediate success of this product, called ORYXE LED, also proves ORYXE Energy's ability to meet its promise to supply a revolutionary new additive to the market.

to make solar electricity cost-competitive with conventional forms of electricity by 2015.

Several interviewees mentioned that the DOE SAI is a good example of a successful federal funding program that can augment venture capital investments in photovoltaic technology. Soliant Energy is an example of a venture capital portfolio company that received SAI funding (**see the description of Soliant Energy on page 32**).

DOE's EERE technology maturation funding program attempts to bridge the gap in technology commercialization funding during the particularly challenging period from prototype and proof of concept to the critical later stages of development and profitable revenues, a period known as the "Valley of Death."

"Using Government Grants to Augment Venture Capital Investment in Clean Technology"

Soliant Energy

www.soliant-energy.com

RockPort Capital Partners

Soliant Energy in Pasadena, California, designs and manufactures concentrator photovoltaic modules for grid-tied and off-grid, residential and commercial uses. Soliant was founded in 2005 and aims to achieve grid-cost electricity via photovoltaic modules by 2010. Soliant's product platform, the Heliotube™ concentrating solar panel, addresses the strong market need for lower-cost, higher-power solutions for rooftop solar power.

In contrast to the other photovoltaic concentrator modules on the market today, the Heliotube panel includes concentration and solar tracking within the traditional form factor of a 4' x 6' solar panel. Heliotube's integrated tracking mechanism provides more uniform power output than traditional flat panels and eliminates the substantial efficiency losses associated with fixed low-concentration modules. In addition, the Heliotube tracking system is self powered and plug-compatible with conventional "flat plate" x-Si products. As a plug-compatible alternative to standard solar panels, Heliotube conforms to the existing standards and practices of the large, established channels of solar installers, integrators, project managers, dealers, and distributors.

In March 2007, Soliant Energy (previously Practical Instruments) was awarded a $4 million grant from the U.S. Department of Energy (DOE) Solar America Initiative (SAI). The DOE SAI grant will allow the company to accelerate development of its Heliotube™ product platform. Soliant's project partners in the SAI award included: Spectrolab, the DOE Sandia National Laboratory, SunEdison, and the Massachusetts Institute of Technology.

Soliant's DOE SAI award is expected to allow the company access to more private equity support if needed in its photovoltaic product line development. Currently, Soliant is funded by leading energy and renewable technology investors, including RockPort Capital, Trinity Ventures, Nth Power, Silicon Valley Bank, and Rincon Venture Partners. A RockPort Capital General Partner serves on the Board of Directors of Soliant Energy.

Usually, there is a 50/50 split in maturation funding between DOE and venture capital firms on various technology investments. Interviewees noted that some collaboration between DOE and EPA already exists on biofuels but more direct DOE and EPA laboratory communications should be explored. Candidate DOE national laboratories for EPA to investigate include the National Renewable Energy Laboratory (NERL), the Oak Ridge National Laboratory (ORNL), the Lawrence Livermore National Laboratory (LLNL), and the Argonne National Laboratory (ANL). The NREL's Industry Growth Forums and its periodic "show and tell" meetings with venture capital firms were cited as useful forums to encourage technology investment and development (**see description of NREL on page 33**). Several interviewees noted that they actively look for technology investment opportunities within the DOE national laboratories.

Several interviewees identified portfolio companies supported by their firms that are successful examples of technology "spin outs" from DOE national laboratories, such as NREL and ORNL. Aldis, Inc., Planar Energy Devices, and M2E Power are three examples of these DOE laboratory originated technologies (**see the description of Aldis, Inc., and Planar Energy Devices on page 35**).

"Government Outreach to Venture Capital Community"

The Department of Energy (DOE) National Renewable Energy Laboratory (NREL) programs with the venture capital community could serve as models for EPA to emulate to help commercialize innovative environmental technologies. Three of NREL's programs to help commercialize promising technologies are described below.

Clean Energy Industry Growth Forums—NREL's Industry Growth Forums provide an opportunity for start-up clean energy companies to present and receive feedback on business plans before a panel of venture capitalists and other business executives. NREL has coordinated 20 Industry Growth Forums, which have facilitated the formation of at least 25 strategic partnerships. Insights from past forums have helped to improve the number and rate of commercial successes in the clean energy industry, and have enabled NREL and DOE to manage and maximize return on technology development investments.

The Clean Energy Alliance—This national alliance of clean energy business incubators helps emerging clean energy companies take more effective advantage of opportunities stimulated by the restructuring of the utility markets, sustainability concerns, and more stringent environmental regulations. NREL catalyzes strategic alliances among select business incubators across the country to provide an array of business and financial services to start-up clean energy companies.

Technology Commercialization Development Fund Program—This new pilot program supports collaboration between researchers and companies to develop commercial products based on NREL innovations. Commercial partners will share 50 percent or more of project development costs, which will typically range from $150,000 to $1 million. Both NREL researchers and outside industry can submit proposals.

Resources and Information for Renewable Energy Entrepreneurs—NREL provides access to informational and how-to resources for renewable energy entrepreneurs, often at little or no charge.

A similar approach adopted by EPA might enhance environmental technology development and investment.

State

Beyond federal programs, several interviewees cited state programs that encourage technology development and investment. The programs most often cited were those in Pennsylvania and California.

The Pennsylvania Department of Environmental Protection (DEP), Office of Energy and Technology Deployment (OETD) serves as state's principal office for energy policy, the assessment of energy and environmental technology, and the promotion of the use of appropriate technology to address environmental problems. OETD's initiatives illustrate and emphasize the common needs of a sustainable economy and a self-sustaining natural environment. As such, OETD's priority projects encourage environmental technology enterprise, expand renewable and advanced indigenous energy opportunities, identify and work to overcome market and regulatory barriers, and promote related economic development in the Commonwealth. In particular, OETD works to make Pennsylvania a center for

environmentally beneficial technology and a natural magnet for the manufacturing jobs associated with these businesses.

In September 2006, the Pennsylvania State Treasurer announced a new Keystone Green Investment Strategy in which Pennsylvania will:

- Reallocate up to $50 million in State Treasury assets to investment managers with a demonstrated track record of investing in clean technology stocks;
- Create a new $40 million investment fund to invest alongside the private sector in cleantech products and firms that benefit Pennsylvania's economy; and
- Develop new investment screens for its investment managers to use when evaluating a company's potential exposure to environmental liabilities.

In February 2004, California State Treasurer Phil Angelides launched the *Green Wave* environmental investment initiative calling on the CalPERS and the California State Teachers Fund (CalSTRS) to implement a four-pronged investment strategy to bolster their financial returns, create jobs, clean up the environment, and combat global warming. The *Green Wave* initiative urged the pension funds to invest $1.5 billion in cutting-edge technologies and environmentally responsible companies, to prod companies to address the financial risks posed by environmental liabilities and global warming, and to reduce energy consumption by their massive real estate holdings.

Non-Government

Several interviewees noted that non-governmental programs such as the New England Clean Energy Council and Ceres—a national network of investors, environmental organizations and other public interest groups working with companies and investors to address sustainability challenges such as global climate change, have been successful in promoting cleantech or environmental technology investments (**see descriptions of the New England Clean Energy Council and Ceres on pages 36 and 37, respectively**).

International

Canadian provincial governments are very active in providing research and financial support to new technology companies. Venture capitalists noted that the Canadian technologies and management teams they see often are better than their U.S. counterparts. Interviewees suggested that the Federal Government investigate and coordinate with technology development and investment programs in other countries, and consider adopting the more successful approaches to improve technology development in the United States.

D. Future EPA Interactions with the Investment Community

With respect to suggestions for future EPA interactions with the investment community, the interviewees' findings were as follows:

1. EPA has few programs that focus on the commercialization stage. Assistance at this stage is critical because many technologies are never

"Technology 'Spinouts' from Government Laboratories"

Aldis, Inc., and Planar Energy Devices

www.aldiscorp.com
www.planarenergy.com

Battelle Ventures

Battelle Ventures, LP, and its affiliate fund, Innovation Valley Partners (IVP), have committed nearly $8 million in start-up financing to two energy-related companies, Aldis, Inc., and Planar Energy Devices, Inc., which are direct spinouts of the U.S. Department of Energy's national laboratories managed by Battelle Ventures' sole limited partner, Battelle Memorial Institute (Battelle).

Aldis, a traffic management technology company focused on energy efficiency, has a joint development agreement with Oak Ridge National Laboratory (ORNL). Planar Energy Devices (Planar), a power-storage company developing thin-film batteries, is a spinout of DOE's National Renewable Energy Laboratory (NREL), as well as a licensee of both NREL and ORNL technology.

Aldis and Planar are examples of how Battelle Ventures has acted as a "founder capitalist," building technology companies from the ground up. With Battelle as a limited partner, Battelle Ventures cannot only deploy a unique set of company-building capabilities, but it also can leverage its position as a bridge between early-stage businesses or technology entrepreneurs and the Battelle network to add value to Battelle Ventures' portfolio companies.

Battelle Ventures investments in Aldis and Planar unfolded differently. For Aldis, assurances of the management team capability came before the technology. The idea for advanced traffic management came from the Aldis cofounders, who Battelle Ventures took to visit ORNL, where some related projects were in development.

Battelle Ventures became aware of the differentiated power-storage technology created at NREL, which became the basis for Planar. Battelle Ventures funded early prototype development of the technology and recruited Planar's Chief Executive Officer for the spinout. Planar then was introduced to complementary work going on at ORNL in the thin-film battery area and, as a result, became a licensee of ORNL technology as well.

commercialized because they cannot bridge the "Valley of Death" (i.e., the particularly challenging period from prototype and proof of concept to the critical later stages of development and profitable revenues).

2. EPA often is viewed by the venture capital community as not being in touch with the world of business and commerce.

3. The EPA Administrator and other EPA senior management officials need to be technology advocates and they need to think expansively about EPA responsibilities related to clean technologies and energy.

4. Most venture capital firms are unaware of what EPA does other than promulgate and enforce environmental regulations.

5. EPA should consider new ways of creating a "stamp of approval" for environmental technologies and recognition programs for plants and other manufacturing facilities.

In the first Environmental Technology Subcommittee report, *EPA Technology Programs and Intra-Agency Coordination*, it became apparent that EPA had few programs to assist technologies at the stage of commercialization. EPA programs assisting technologies in this phase of the continuum have experienced substantial budget and resource reductions in recent years. Interviewees noted that EPA assistance at this stage could provide the impetus needed to interest the investment community in promising new technologies.

"Regional Mechanism for Bringing Together Venture Capitalists, Industry, Academia, and Government to Accelerate the Region's Clean Energy Economy"

The New England Clean Energy Council's mission is to accelerate New England's clean energy economy to global leadership by building an active community of stakeholders and a world-class cluster of clean energy companies.

The Council represents a diverse set of stakeholders, including the industry associations, area utilities, local universities, labor, and large commercial end-users. The Council also includes 30 Chief Executive Officers of the region's leading clean energy companies, representatives from most of Massachusetts' top 10 law firms, and partners from more than a dozen of the top New England venture capital firms (with a total of more than $8 billion under management). The Council serves as a forum through which these players collaborate on common interests.

The Council focuses its resources on five key areas, each of which has a significant impact on fulfilling the organization's stated goal of accelerating the region's clean energy economy. These focus areas are innovation, growth, analysis and education, market adoption, and policy.

EPA often is viewed by the venture capital community as not being in touch with the world of business and commerce. This lack of contact has produced and may be in part be caused by cultural differences that include the language that is used, the issues that are most important, the types of people who are involved, the ways of doing business, and others. It would be beneficial to EPA, the venture capital community, the environment, and the economy for EPA to engage with the venture capital community in significant ways to bridge this cultural divide and bring together the resources of both sides.

Increasingly there are shared values for EPA and the investment community in believing that protecting and improving the environment are both important ends in themselves and important for creating new business opportunities. The major issues forcing this convergence are the very strong belief that climate change is real and needs to be recognized by government as a threat that requires government leadership and the need for energy independence which drives investment in alternative and renewable energy sources.

The Administrator and other senior management need to be technology advocates; to think expansively about EPA's responsibilities related to cleantech and energy, including moving into areas that have been seen as the purview of DOE; to create new mechanisms to support investment in innovative technology development and commercialization, in part by learning from DOE and other federal, state, local, and private sector organizations.

"National Mechanism for Bringing Business, Capital Markets, and Environmentalists Together to Help Corporate Governance Address Climate Change"

Ceres (http://www.ceres.org) is a national network of investors, environmental organizations and other public interest groups working with companies and investors to address sustainability challenges such as global climate change. Ceres' mission is to integrate sustainability into capital markets for the health of the planet and its people.

At its founding in 1989, Ceres introduced a bold new vision to the business community. That vision is of a world in which business and capital markets promote the well being of human society and the protection of the earth's biological systems and resources. Ceres advances its vision by bringing investors, environmental groups, and other stakeholders together to encourage companies and capital markets to incorporate environmental and social challenges into their day-to-day decision-making. Ceres has received numerous awards including the 2006 Skoll Award for Social Entrepreneurship and the Fast Company/Monitor Group Social Capitalist award, and was named one of the 100 most influential players in the corporate governance movement by Directorship Magazine. By leveraging the collective power of investors and other key stakeholders, Ceres has achieved some dramatic results:

- Launched the Global Reporting Initiative (GRI), now the de-facto international standard used by more than 1,200 companies for corporate reporting on environmental, social and economic performance.
- Partnered with Yale University and the insurance firm Marsh to create the Sustainable Governance Forum on Climate Risk, a unique leadership development program designed to help corporate leaders address the problem of climate risk.
- Spearheaded dozens of breakthrough achievements with companies, such as Nike becoming the first global apparel company to disclose the names and locations of its 700-plus contract factories worldwide in 2005, Dell Computer agreeing in June 2006 to support national legislation to require electronic product recycling and "takeback" programs, and Bank of America announcing a $20 billion initiative in March 2007 to support the growth of environmentally sustainable business activity to address global climate change.
- Brought together 500 investor, Wall Street, and corporate leaders at the United Nations in 2005 to address the growing financial risks and opportunities posed by climate change. The ground-breaking meeting included 28 U.S. and European investors approving a 10-point action plan seeking stronger analysis, disclosure, and action from companies, Wall Street, and regulators on climate change. Another investor summit will be held in February 2008.
- Launched and directs the Investor Network on Climate Risk (INCR), a group of more than 60 leading institutional investors with collective assets exceeding $4 trillion.
- Published cutting-edge research reports to help investors better understand the implications of global warming. Among those: a January 2007 report, *Climate Risk Disclosure by the S&P 500*, an August 2006 report, *From Risk to Opportunity: How Insurers Can Proactively and Profitably Manage Climate Change*, and a March 2006 report, *Corporate Governance and Climate Change: Making the Connection*, which analyzed how 100 of the world's largest companies are addressing the business challenges from climate change.

Need for Leadership at the Top

The role of the Administrator is very important in establishing a relationship with the venture capital community. The Administrator's involvement is essential for EPA to be viewed as trying to make its work more relevant to the investment community.

Interviewees viewed this study as a good first step because the recommendations will go to the Administrator. One of the first things the Administrator can do in response to this study is to host a national roundtable of senior venture capitalists to begin a dialogue between EPA senior management and the investment community. The national meeting could be followed by regional EPA-investor meetings that will extend this dialogue. At some point these dialogues should include technology developers, academia, and other appropriate public and private organizations.

There also can be mechanisms created that will enable an "open door" of easy communication with senior members of the investment community on a continuing basis. One way would be to create an advisory panel that includes members of the investment community so they can participate in studies and give advice to the Administrator. Another way is to periodically meet for a short period with the most senior members of the investment community, which would permit a "taking of the pulse" of concerns, needs, approaches, and other issues.

The Administrator is also uniquely able to bring both policy and technology issues into discussions with venture capitalists. The plans for and status of regulations and enforcement are important types of information that the investment community needs and wants. This ranges all the way from the question of carbon taxes and "cap and trade" to municipal wastewater treatment plants. These issues have important consequences for the venture capital community's investment in innovative technology development and commercialization.

Investors' risk calculations sometimes include the likelihood of a new government regulation being put into effect and the lead time needed to develop breakthrough technologies. The intelligence that EPA senior management can offer in this regard coupled with the Agency's understanding of the most important technology needs and the existence of new ideas and approaches are very important for these investors. Companies have staff members who concentrate on a specific technology area and whose job is to find out this type of information. The more proactive EPA can be in helping companies to find this information, the more relevant those companies will view a continuing relationship with EPA.

Need for Communication Follow-Through

Venture capital firms would be interested in knowing what the Agency cares about and what its resources are in terms of technology, technical expertise, facilities, testing capabilities, etc. EPA can provide this information to the venture capital community in part by attending and making presentations at investor conferences and other meetings. These are opportunities to describe the most important environmental problems EPA is addressing and what the technology needs are to solve them, as well as some of the latest EPA and non-EPA technology developments that EPA has found.

EPA can use its Web site to offer easy access to information about technology development activities that might offer investment opportunities. It can use email to directly target key venture capital firms that are making cleantech and environmental technology investments. EPA can open its laboratories to visits by venture capitalists so they can not only learn about the latest technology developments but also talk with the researchers and possibly establish continuing relationship that could result in investment in the future.

Need for Programmatic Follow-Through

To connect with and enhance EPA's ability to substantively work with the venture capital community it is necessary to have adequate programmatic and resource capabilities.

Programmatic follow-through between EPA laboratories and venture capital companies can be through the development of cooperative research and development agreements (CRADAs). As EPA works more closely with the investment community, there will be increased opportunities for third party funding of the development of innovative technologies.

Interviewees noted that CRADAs have been useful in commercializing technologies that have originated from government laboratories. M2E Power is an example of a technology that originated in the DOE Idaho National Laboratory and was commercialized using a CRADA (**see the description of M2E Power on page 40**).

If there is a good relationship a venture capital firm and an EPA laboratory, for example, the venture capital firms may bring companies they have found that are developing new technologies to the laboratory to create a working relationship among all three parties. This could result in new cost-sharing arrangements.

There is a great need for EPA to invest more in its current technology development and commercialization-related programs and to create new types of supports for these purposes.

Current programs include the SBIR program and the ETV program. EPA could increasingly encourage and assist the use of third-party evaluations. EPA could support technology demonstrations at federal facilities. Air purification, water membranes, and sterilization may be areas where technology demonstrations could be conducted at federal facilities. There is less

interest in federal remediation demonstrations by investors because the exit strategy for these companies is difficult.

EPA can look at new ways of creating a "stamp of approval" for technologies, which can include recognition through programs like Energy Star and through awards and public statements. EPA could consider an Energy Star program for plants and manufacturing facilities. If manufacturing plants realized that additional energy efficiency or more pollution reductions would merit EPA recognition, this could make a major difference (e.g., raise employee morale). Public recognition can be a strong personal and corporate motivator.

"Utilizing CRADAs to Demonstrate and Commercialize Innovative Technologies"

M2E Power

www.m2epower.com

@Ventures

M2E Power, Inc., a Boise, Idaho company, has developed a micro-generator that converts everyday human and vehicle motion into enough energy to power mobile electronic devices. The company expects its technology—an advance on the technology found in devices like self-winding watches and battery-free flashlights—will eventually power cell phones, digital cameras, and portable entertainment players. For now, however, the company is focusing on powering mobile devices on the battlefield.

The patent-pending M2E™ (Motion to Energy) technology originated though a cooperative research and development agreement (CRADA) with the Department of Energy's Idaho National Laboratory (INL). Inventor Eric Yarger and his team at the INL sought to ease the military's battery dependence for mobile power and offer soldiers a way to generate power as they move around. It leverages the well-proven Faraday Principle (energy produced via motion of a magnet through a wire coil), but with changes in the magnetic architecture that have broad applicability to many sizes of motor generators.

In November 16, 2007, @Ventures, the clean technology venture capital business of CMGI®, Inc., announced that it made a $2.0 million investment in M2E Power, Inc. @Ventures participated in the company's $8 million Series A financing round, along with OVP Venture Partners, Highway 12 Ventures and existing investors.

M2E Power will use the funds to speed commercialization of its M2E™ technology, which has the potential to fundamentally transform the way military and consumer mobile devices are powered. M2E's core technology also is potentially applicable to large-scale power generation, such as wind, wave, and most other electromagnetic induction-based generation technologies.

M2E is an eco-friendly, cleantech solution that can significantly reduce carbon emissions in larger applications. Depending on usage, it may not need to draw from power grids to recharge itself. It eliminates up to 30 percent of the highly toxic heavy metal contained in typical batteries and—by doubling battery life—cuts in half the number of batteries discarded in landfills.

EPA can investigate "Entrepreneur-in-Residence" and "Entrepreneurial Fellows" programs as a means of exposing successful entrepreneurs to environmental technologies (**see description in the text box on page 41**).

EPA can develop new ways to provide financial backstopping for innovative technologies. These include providing seed funding to small companies at the early stages of technology development. It can include grants that are more substantial at later stages. It can provide loan guarantees so if investment and utilization of innovative technologies fail, there can be financial support to lessen the cost to the investor. There also can be use of revolving funds.

"Government Partnering with Venture Capitalists to Commercialize Technology from Federal Laboratories"

On February 27, 2008, DOE announced the competitive selection of three venture capital firms to participate in its newly established Entrepreneur-in-Residence (EIR) pilot program, which aims to accelerate deployment and commercialization of advanced clean energy technologies from three DOE national laboratories into the global marketplace. The EIR pilot program provides venture capital-sponsored entrepreneurs with access into three of DOE's national laboratories to accelerate adoption of advanced renewable energy and energy efficient technologies to fundamentally transform how the nation is powered. DOE is leveraging private-sector expertise in new ways to capitalize on cutting-edge technologies that are ripe for commercialization.

The EIR pilot program involves placing venture capital-sponsored and selected entrepreneurs in three of DOE's national laboratories to identify laboratory-developed technologies funded by DOE's Office of Energy Efficiency and Renewable Energy, and to develop business cases for their commercialization. DOE has selected Kleiner, Perkins, Caufield & Byers in Menlo Park, California, to work with DOE's National Renewable Energy Laboratory, ARCH Venture Partners in Chicago, Illinois, to work with DOE's Sandia National Laboratory, and Foundation Capital in Menlo Park, California, to work with DOE's Oak Ridge National Laboratory. Each laboratory will host one entrepreneur-in-residence for an initial period of 1 year, and DOE will support this work by providing up to $100,000 for each entrepreneur to help defray salary and other expenses. Each firm will match DOE funding and may contribute additional funds to support its entrepreneur's work. Using their vast business expertise, the selected firms will be permitted to give proven start-up entrepreneurs the opportunity to work directly with laboratory staff for a hands-on look at various, commercially viable technologies.

Entrepreneurs will conduct technology assessments, evaluate market opportunities, formulate preliminary business cases, and propose business structures in an effort to bring cutting-edge technologies to market.
Upon selecting a technology for commercialization, entrepreneurs-in-residence and their venture capital sponsors would negotiate a license to use the laboratory-developed technology. Working with their respective entrepreneur, the venture capital sponsors will form and finance a start-up business based on the licensed technology. The foundation of each start-up's business plan would be the commercialization of licensed clean energy technologies.

To further accelerate the commercialization process, the EIR pilot program seeks to utilize a Standard License Agreement—built off the structure of successful university licenses—that is tailored for entrepreneurs and small businesses. The Standard License Agreement includes a provision that would permit the EIR to offer partial ownership of the start-up company as full or partial payment for the license. This provides the opportunity for a start-up company to use its initial resources to grow the company rather than to make substantial up-front cash royalty payments.

E. Actions of Venture Capital Firms to Help EPA Encourage Environmental Technology Development and Demonstration

Interviewees identified several actions that venture capitalists could do to encourage environmental technology development and demonstration. These actions include:

- **Conduct Direct, Routine Communications with Key EPA Managers and Staff About Legislative or Environmental Policy Issues Affecting Clean**

Technology Development—Several interviewees believed that the recently passed Energy Independence and Security Act, Public Law 110-140, signed on December 19, 2007, represents a revolutionary boost for ethanol production. Routine communications between EPA managers and staff (e.g., the SETO and RTAs) and venture capitalists about existing laws and their impact on technology development could be beneficial. Further, they thought that alerting EPA managers and staff to venture capital investment considerations might encourage the Agency to better understand commercialization opportunities for environmental technologies. Some interviewees offered to meet with EPA managers and staff in Washington, DC, during their periodic visits to the area to discuss venture capital investments in clean technologies.

- **Co-Sponsor an "Entrepreneur-in-Residence" Program at EPA Laboratories**—Several interviewees suggested that EPA review the DOE NREL and MIT Entrepreneur-in-Residence (EIR) programs for possible application in the EPA labs. Potential "pools" of entrepreneurs could be identified and vetted through partnerships with private-sector organizations. Supporting private-sector organizations for EIR partnership could include: non-profit organizations such as the New England Clean Energy Council; venture capital firm(s); or national trade associations such as the National Venture Capital Association, the National Association of Small Business Investment Companies, and others.

- **Broker Partnerships Between DOE and EPA or EPA and the Small Business Administration (SBA) on Technology Development Issues**—Several interviewees noted that their portfolio companies have already "spun out" technologies from DOE national laboratories and in some cases combined innovative technologies across laboratories or "brought innovative technology ideas" into national laboratories for investigation. Venture capital firms could broker technology concepts between DOE and EPA laboratories and possibly co-fund development of these technology demonstrations.

  The SBA has licensed Small Business Investment Companies (SBICs) for over 50 years. Although no interviewees were SBIC-affiliated firms, officials from these firms through their trade association—the National Association of Small Business Investment Companies (NASBIC)—might be able to identify environmental technologies of mutual interest between SBA and EPA.

- **Invite EPA Officials to Visit Environmentally Beneficial Venture Capital Sponsored Technology Demonstrations**—Several interviewees had portfolio companies that were developing innovative environmental technologies or technologies that were being commercialized based on prototypes developed at DOE national laboratories or academic institutions. Visits of EPA experts to these portfolio companies could offer the Agency an opportunity to review these technologies and give EPA officials examples of how similar technology demonstrations might be conducted based on EPA sponsored prototypes.

- **Volunteer to Participate on EPA Advisory Boards and Committees**—Several venture capitalists acknowledged that they actively serve on advisory boards for DOE national laboratories. These interviewees also expressed interest in serving on EPA advisory boards to provide advice to the

Agency on how EPA can encourage venture capital investment in promising environmental technologies. Venture capital representatives also could make presentations to Agency offices, boards, work groups, etc., concerning actions EPA can take to encourage investment in environmental technology.

- **Identify Models for EPA Officials to Consider to Address High Priority Environmental Problems**—Interviewees argued for EPA to consider market mechanisms, with regulators and investors working together, to address high priority environmental problems like climate change. One successful model that was cited was the joint meetings among the California Environmental Protection Agency (CalEPA), the California Public Utilities Commission (CPUC), and CalPERS that have been conducted for the past 2 to 3 years to address California energy and environmental issues.

- **Invite EPA Officials to Speak at Cleantech Conferences, Forums, and Meetings—**Several interviewees said that EPA officials have been noticeably absence from cleantech activities. National trade association meetings and regional venture capital or investor forums may offer opportunities for Agency representatives to make presentations and/or routinely participate in networking activities.

  San Francisco, California, and Boston, Massachusetts, are the two most active U.S. regions in cleantech investments. Six of the nine interviewees had offices in one or both of these locations and routinely participated in local venture capital forums and conferences.

- **Review and invest in EPA Small Business Innovation Research (SBIR) Program Technologies**—Nearly all of the interviewees were familiar with the federal SBIR Program. Although none of the interviewees had portfolio companies that commercialized an SBIR technology, several interviewees expressed interest in reviewing EPA's SBIR-sponsored technologies.

  The venture capital community also could advertise through its networks SBIR solicitations and awards, as well as potentially advise SBIR recipients where additional funding may be available. Venture capital representatives also expressed interest in serving on an EPA advisory committee on SBIR activities.

V. Next Steps – Work Group Recommendations

A common, notable theme among the venture capital investors interviewed is that there is a growing interest in environmental technologies, spurred by awareness of global issues such as climate change and the diminishing sources, high costs, and environmental consequences of carbon-based energy. Also of concern are the decreasing availability and increasing costs of other essential resources such as clean water. An expanded interest in environmental responsibility stimulates interest and awareness of new technologies, and the global marketplace increasingly strives to recognize the business as well as social costs of negative environmental consequences.

Many individual and institutional investors are seeking opportunities to invest in the growing environmental technology sector. There is a vast amount of capital available for investment. Returns on investment, however, still must compete with other investment options. Therefore, it is critical to investors that areas of investment risk—often based on regulatory uncertainty and unpredictability—be identified and reduced.

Horizons for investment contemplate long-term potential for the technology, and a predictable forecast of the regulatory environment is essential to reduce uncertainty. Moreover, the new challenges that will be solved by emerging technologies often require a new regulatory framework. Delays in establishing that regulatory framework impede investment in new technology by perpetuating the risk of an uncertain, unpredictable market.

For these reasons, effective stimulation and adoption of new technology requires timely regulatory action. EPA must accelerate its engagement with new technology developers and investors, and commit to a credible, long-term advocacy of new technology.

The venture capitalists interviewed in this study and the Work Group members identified some specific actions that EPA and the venture capital community can take to stimulate early-stage investment and improve the promotion and adoption of new technology.

It is important that the Agency initiate action promptly to signal its commitment to stimulating and supporting the development of new technology solutions. Some low-cost but highly visible actions could have immediate impact and result in immediate gains. Others will require a long-term commitment by the Agency. Some of the recommendations will require funding, while others depend on leveraging the Agency's regulatory authority or its cumulative technical and scientific know-how to influence the market and investors. The Environmental Technology Subcommittee urges EPA and the venture capital community to consider the following recommendations and take timely action to implement them.

A. Recommendations for EPA

Key Recommendations

1. **Recognize carbon dioxide, greenhouse gases, and climate-change related pollutants as pollutants that are addressed in Goal 1 of EPA's Strategic Plan (Clean Air and Global Climate Change*) and take priority measures within EPA's authority to establish standards and long-term regulations for these pollutants, thereby signaling to investors the predictability and certainty deemed necessary to drive the market for environmental technologies.**
    a. Establish a clear regulatory framework for carbon dioxide, greenhouse gases, and climate change-related technologies.
    b. Include in the Strategic Plan a focus on technology objectives that address environmental consequences related to climate change.
    c. Host a Climate Change Technology Symposium with regulators and investors to discuss new technology solutions to the environmental challenges of climate change.
    d. Publish long-term regulatory outlooks for other emerging technologies in such market segments as alternative energies, nanotechnology, and pharmaceuticals.

2. **Forge and sustain communications with the early-stage investment community.**
    a. Host a recurring event for venture capital investors to meet with senior EPA officials, including the EPA Administrator, the Assistant Administrator for Research and Development, the EPA Science Advisor, the EPA Laboratory/Center Directors, the Senior Environmental Technology Officer, and the Regional Environmental Technology Advocates, and announce EPA's commitments to developing new technologies to solve environmental problems.
    b. Host open, accessible events that facilitate communication and dialogue among aspiring technology developers, investors, EPA, other regulatory bodies, and partners and reflect EPA objectives.
    c. Encourage headquarters program and regional office officials to attend investor and new technology events sponsored by organizations such as:
        - Angel Capital Association
        - National Venture Capital Association
        - National Association of Seed and Venture Funds
        - National Business Incubator Association
    d. Encourage EPA managers, scientists, and engineers at all levels to engage with new technology developers and investors, including personal visits to early-stage firms, particularly those developing and commercializing technologies funded by venture capitalists.
    e. Establish a Technology Investment Advisory Board, as an independent advisory body or a standing committee of NACEPT or the EFAB.
    f. Encourage the Environmental Technology Council and Action Teams to invite the investment community to participate in discussions of desired technologies.

*"Protect and improve the air so it is healthy to breathe and risks to human health and the environment are reduced. Reduce greenhouse gas intensity by enhancing partnerships with business and other sectors." Goal 1. Clean Air and Global Climate Change. U.S. Environmental Protection Agency. *2006-2011 Strategic Plan: Charting Our Course.* EPA-190-R-06-001. Washington, DC, 2006. Available at http://www.epa.gov/ocfo/plan/plan.htm.

3. **Strengthen financial support (e.g., loan guarantees, grants, revolving loan funds) and reduce regulatory risks for new technology development during the commercialization period.**
    a. Fully fund the SBIR Program beyond the mandatory 2.5 percent of the R&D budget level and include an additional 1 percent for commercialization support. Also encourage co-funded SBIR grants with other federal agencies.
    b. Establish closer SBIR partnering relationships among EPA program and regional offices to share financial and technical support for adoption of SBIR technologies.
    c. Increase the funding and scope of EPA's Environmental Technology Verification Program.
    d. Implement flexible enforcement requirements that allow use of emerging new technologies that have been verified under EPA's ETV Program.
    e. Provide loan guarantees to new technology companies.
    f. Increase EPA laboratory research funding by 20 percent annually and designate this funding to specifically support technologies that can be commercialized.
    g. Offer research grants to colleges and universities to pursue commercialization of technical solutions to solve specific EPA technology challenges.
    h. Substantially increase the number of CRADAs that EPA laboratories establish with private-sector partners. Fund grants for demonstration, pilot testing, and initial commercial deployment of technologies related to addressing climate change concerns.

4. **Take steps to streamline permitting for commercial scale-up of new, innovative environmental technologies.**
    a. Issue policy for streamlining the permitting process for commercial scale-up of new, innovative environmental technologies to encourage capitalization for taking these new clean technologies to commercial scale. During this commercialization phase, streamlined permitting and consistent enforcement become increasingly important.
    b. Seek opportunities to work with regions, states, tribes, and municipalities to pilot a streamlined permitting process to address priority problems. Such an approach was used by Region 1's Center for Environmental Industry and Technology in collaboration with the Interstate Technology and Regulatory Council to address septic systems, arsenic removal technologies, and site characterization.

5. **Enforce environmental regulations consistently, to clarify needs and avoid uncertainty.**
    a. Establish long-term regulations to reduce regulatory risk in a timely manner. When environmental regulations are reliably enforced, investors are able to gauge the potential market for new technology penetrations.
    b. Maintain a vigorous enforcement policy and drive technology through laws and regulations; this reduces uncertainty in the marketplace.

6. **Support metrics and monitoring of new technologies.**
    a. Develop an EPA capability to verify the effectiveness of new environmental technologies.
    b. Develop an EPA capability to verify the effectiveness of clean technologies; objectively validate the net environmental benefit of a technology adoption.
    c. Expand and promote the Environmental Technology Verification Program.
    d. Implement a recognition program for technologies that are successfully validated in a metrics and monitoring program, and/or are successfully validated by EPA's ETV Program.

Additional Recommendations

The following additional recommendations will further spur EPA support for environmental technology development and commercialization.

1. **Establish and promulgate management and policy changes within EPA to encourage internal support for new technology development.**
    a. Publicly announce appointments of the EPA Senior Environmental Technology Officer and Regional Environmental Technology Advocates.
    b. Use internal and external communication mechanisms to recognize successful technology adoptions throughout EPA.
    c. Encourage the Environmental Technology Council and Action Teams to invite the investment community to participate in discussions about technology development and commercialization issues.
    d. Recognize and reward EPA employees responsible for solving environmental problems through successful new technology applications.
    e. Create incentives for EPA research laboratories to support the development and commercialization of environmental technologies arising from EPA research.

2. **Increase public advocacy for new technology.**
    a. Announce EPA interests to identify possible technology solutions to address high-priority environmental problems. Publish and maintain an active list of specific problems for which new technology solutions are sought.
    b. Establish policy advocating support for innovative technology approaches to solve the most critical environmental problems.
    c. Publicly advocate for new technologies that solve environmental problems; communicate the sense of urgency for new technologies development and use.
    d. Use the EPA Science Forum as an opportunity to review new technology initiatives and to recognize EPA staff and partners for technology achievements.
    e. Create a public electronic database of successful new environmental technologies.
    f. Establish a Web-based "clearinghouse" or database that serves as a referral service for technology investment opportunities and challenges.

g. EPA should provide technical and economic information so that companies can overcome the initial hurdles to investing in innovative technologies. EPA also should provide technical and economic information so that investors do not overinvest in a particular technology.

3. **Use collaborative relationships and partnerships to further public funding and private investment in technology development.**
    a. Increase collaborative technology development programs by active partnerships with federal agencies, states, tribes, and other stakeholder organizations, including industry organizations.
    b. Work with federal and state agencies to provide access and support for technology demonstrations and pilot programs on federal facilities, including military facilities being converted for other uses through the Base Realignment and Closure (BRAC) program.

4. **Model EPA technology support activities after other successful programs.**
    a. Adopt technology development programs demonstrated effective by the DOE national laboratories.
    b. Address Intellectual Property Rights issues for government researchers. The government should find some way to allow these researchers to share in invention royalties.
    c. Link EPA laboratories with business incubators, other entrepreneurial development organizations, and the investment community.
    d. Open EPA laboratories to visits by venture capitalists to allow them to learn about technology developments and establish a relationship that could result in future co-investments.
    e. Establish an Entrepreneur-in-Residence program at EPA laboratories similar to that underway at three DOE national laboratories.
    f. Investigate and coordinate with technology development and investment programs in other countries and consider adopting the most successful approaches to improve technology development in the United States.

5. **Clearly state technology development and commercialization objectives.**
    a. Include technology development objectives in the EPA Strategic Plan as well as the Agency's other plans.

B. Recommendations for the Venture Capital Community

1. **Collaborate with EPA to establish metrics and monitoring strategies for new technologies to measure and document demonstrated actual performance of these technologies.**
    a. Consider metrics and monitoring measurements to document the effectiveness of new technologies.
    b. Collaborate with EPA to see that the performance measurements address metrics that are related to anticipated regulations and standards.

2. **Participate in environmental technology verification programs and EPA-supported metrics and monitoring programs.**
    a. Consider EPA SBIR-sponsored technologies for potential investments.
    b. Use industry and investment community networks to promote SBIR solicitations and awards, and advise SBIR recipients where additional funding may be available.
    c. Serve on an EPA advisory committee focused on SBIR activities.
    d. Encourage investment companies to participate in EPA's Technology Verification Program.
    e. Collaborate with EPA to develop and implement metrics and monitoring programs relevant to new technologies.

3. **Encourage communication and interaction among technology developers, investors, and EPA.**
    a. Sponsor Entrepreneur-in-Residence (EIR) programs for possible application in the EPA laboratories. Potential "pools" of entrepreneurs could be identified and vetted through partnerships with private-sector organizations.
    b. Support private-sector organizations for EIR partnerships, which could include: non-profit organizations such as the New England Clean Energy Coalition, venture capital firm(s), or national trade associations such as the National Venture Capital Association, the National Association of Small Business Investment Companies, and others.
    c. Alert EPA officials to venture capital investment considerations to better understand commercialization opportunities for environmental technologies.
    d. Meet with the Senior Environmental Technology Officer (SETO) and other EPA officials in Washington, DC, to discuss venture capital investments in clean technologies.
    e. Meet with the EPA Regional Technology Advocates and other regional officials to maintain mutual awareness of new technologies.
    f. Invite EPA officials to visit environmentally beneficial venture capital sponsored technology demonstrations.
    g. Invite EPA officials to participate in investment organization conferences and events. h. Participate in EPA advisory boards, councils, and committees.

4. **Provide opportunities for EPA to financially support promising new environmental technologies through existing and new financial support programs.**
    a. Propose loan guarantees or grant approaches that would enhance investments in environmental technologies.
    b. Encourage firms to seek funding support through EPA's SBIR Program and verification support through EPA's ETV Program.
    c. Introduce EPA to market mechanisms that would allow regulators and investors to work together to address high-priority environmental problems (e.g., the joint meetings among the California Environmental Protection Agency (CalEPA), the California Public Utilities Commission (CPUC), and CalPERS that have been conducted for the past 2 to 3 years to address California energy and environmental issues).

Appendix A: Venture Capital Work Group Members

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Appendix B: Charge to the Work Group

Charge to the Venture Capital Work Group of the NACEPT Subcommittee on Environmental Technology

I. Reasons for the Study

The Subcommittee in its first report, *EPA Technology Programs and Intra-Agency Coordination*, May 2006, which can be found on www.epa.gov/etop, developed the EPA Environmental Research and Development Continuum. The Continuum shows that EPA does not have programs that support the commercialization of technology. This means that environmental technologies developed by EPA and by others with and without EPA support must largely rely on funding from the private sector if they are to be commercialized and used to protect public health and the environment.

In its second report, *EPA Technology Programs: Engaging the Marketplace*, May 2007, also available on the ETOP, the Subcommittee emphasized the need for EPA to partner with outside organizations to develop and commercialize environmental technologies, and to help put them into use. This means that EPA should work with the private sector to find ways to increase investment in the commercialization of environmental technologies.

As a result, EPA wants to open communication with the investment community to get its advice on actions that EPA and the investment community could take and partnerships they could create to achieve the goal of greater private sector investment in the commercialization of environmental technologies over the long-term.

II. Content of the Study

The study should address the following questions:

A. **Current Investment Practices.** What is the nature of current private sector investment in environmental technology? Who are the investors? How do they differ in their investments? How much are they currently investing? How do investors and developers find each other? How do investors manage their investments? How do they judge the success of their investments? Give examples of successful investments by different types of investors in environmental technology.

B. **Future Investment.** What are the prospects for investment in environmental technology in the future? What are the determinants of this prospective future? What sectors or applications of environmental technology will be likely to attract investment and why? What is the likely magnitude of these investments? Are there likely to be new or improved mechanisms to help investors and developers find each other? What is hindering and helping the development of dedicated environmental funds? What could industry do—either by itself or with EPA as a partner to enhance investment in environmental technology?

C. **Current EPA Role.** To what extent and how is EPA a factor in current investment decisions? When have EPA regulations helped and hindered investment (give examples)? Do EPA voluntary programs lead to investment (give examples of those that work)? What is the role of technology assessment and

verification in making investment decisions? To what extent is there contact with EPA—e.g., Regional Offices, program offices, research office—and for what purposes? To what extent are investors aware of EPA-developed technologies? How do they find out about them? What is EPA doing that helps and hinders investment in those technologies? Does the industry have successful interactions with other Federal agencies from which EPA could learn? Do those Agencies have programs or policies that EPA could emulate or partner with? If so, what are they and how could EPA best make use of them?

D. **Future EPA Role.** What can EPA do to make investment in environmental technology more attractive and to facilitate that investment? Would it be helpful for EPA to communicate its priority environmental problems? What would be the most effective and efficient communication mechanisms between EPA and the industry—with whom and for what purposes? Are their barriers that EPA can remove to encourage investment? Are there actions EPA can take to facilitate investment? What kinds of long-term partnerships between EPA and the investment community would be useful—with whom, for what purposes, and using with what mechanisms?

III. Process for Carrying Out the Study

The Subcommittee is being asked to create a small work group consisting of members of the Subcommittee and members of the investment community. The work group will meet by teleconference and conduct its work by telephone and email, unless otherwise specified by EPA.

The work group members will use existing reports about investment in environmental technology, their own experience, and contacts with knowledgeable people in the investment community to gather, analyze, and write up contextual and background information on venture capital investment in environmental technology. This material will inform the work group's discussions and can be used in the work group's report both as part of the text and in an appendix.

The work group will conduct structured interviews of no more than nine individuals who comprise an informed group of venture capitalists and others with complementary experience and knowledge of investment in environmental technology. The work group, with EPA support, will design and do a limited pretest of the questionnaire that will be used for these interviews.

The product of this work group will be a letter report to the EPA Administrator that gives background, findings, and recommendations. It is not expected that this report will be bound, but that will depend on its length and other considerations at the time of its completion.

It will be useful to have at least one early draft of the outline and initial information and thoughts reviewed by the Subcommittee by January 15, 2008. The work group must complete it final report, including obtaining Subcommittee approval, by March 30, 2008.

Appendix C: Venture Capital Community Interviewees

Interviewee	Affiliation	Capital Under Management
Rob Day	@Ventures	$100 million
John DeVillars	BlueWave Strategies	$2 million
Hank Habicht	SAIL Venture Partners	$170 million
Winston Hickox	California Strategies	Not Applicable
Kef Kasdin	Battelle Ventures	$220 million
Eric McAfee	Cagan-McAfee-Capital Partners	$500 million
Chuck McDermott	RockPort Capital Partners	$386 million
William Reilly	Aqua International Partners/ Texas Pacific Group	$1,500 million
Rosemary Ripley	NGEN Partners	$250 million
TOTAL CAPITAL UNDER MANAGEMENT		**$3.13 billion**

Interviewee Biographical Sketches

Rob Day, Principal, @Ventures
www.ventures.com

Rob Day, joined @Ventures in 2007, and operates out of the company's Boston-area office. He currently holds an observer seat on the boards of Powerit Solutions and M2E Power.

Prior to joining the @Ventures team, Mr. Day was an investor with Expansion Capital Partners for more than 2 years, where he was an investment principal responsible for various aspects of that firm's clean technology venture capital activities, including investments in Tiger Optics, SensorTran, and Orion Energy Systems.

Mr. Day was formerly a consultant with Bain & Company, where he worked with companies and evaluated private equity transactions in the energy/utilities, telecommunications, information technology, health care, and retail industries. Earlier in his career, Mr. Day was a founding member of the World Resources Institute's Sustainable Enterprise Program, where he developed partnerships with companies across a wide range of industries to foster new business opportunities with economic, environmental, and social benefits.

Mr. Day is the co-author of *The Next Bottom Line: Making Sustainable Development Tangible,* co-leads the Renewable Energy Business Network (www.rebn.org), and authors the Web site Cleantech Investing (www.clean-techvc.com). Mr. Day also serves on the boards of the New England Clean Energy Council and GreenTech Media. Mr. Day received his M.B.A. at Kellogg Graduate School of Management (Northwestern University), and his B.A. at Swarthmore College.

John DeVillars, Partner, BlueWave Strategies
www.bluewavestrategies.com

John DeVillars is a Founder and Partner of BlueWave Strategies and Managing Partner of its affiliated investment group, BlueWave Capital. He currently advises Brownfield developers and environmental and renewable energy companies in the areas of project management, financing and capital sourcing, regulatory approvals, community and government relations, and business development.

From 2000 to 2003, Mr. DeVillars served as the Executive Vice President of Brownfields Recovery Corporation, a Boston-based real estate investment and development company that focuses on environmentally impaired properties. From 1994 to 2000, he served as the New England Administrator of the U.S. Environmental Protection Agency. Previously, Mr. DeVillars served as Secretary of Environmental Affairs for the Commonwealth of Massachusetts, Chairman of the Board of the Massachusetts Water Resources Authority, and Chief of Operations for Massachusetts Governor Michael Dukakis. From 1991 to 1994, he was Director of the Environmental Services Group for Coopers & Lybrand, where he initiated and led the firm's environmental management systems group.

Mr. DeVillars holds an M.P.A. from Harvard University and a B.A. from the University of Pennsylvania. He serves on the Board of Directors of Clean Harbors, Inc., and the Massachusetts Environmental Trust as well as several other privately held energy and environmental corporations and nonprofit organizations.

Hank Habicht, Managing Partner, SAIL Venture Partners
www.sailvc.com

Hank Habicht joined SAIL Venture Partners in 2005 and works in the company's Washington, DC office. Mr. Habicht is the Chief Executive Officer for the Global Environmental & Technology Foundation (GETF), a 501(c)3, not-for-profit corporation that fosters innovation in environmental management and applications of clean technology that make business and environmental sense. He is the Co-founder and Principal in Capital E, LLC, a management consulting firm that works with energy technology companies in areas such as solid oxide fuel cells, photovoltaic modules, combined heat and power projects, and bio-energy plants.

Previously, Mr. Habicht was Senior Vice President of Safety-Kleen, and served as Deputy Administrator and Chief Operating Officer at the U.S. Environmental Protection Agency. He is a co-founder of the American Council on Renewable Energy and an advisor to the Secretary of the U.S. Department of Energy. Mr. Habicht received his bachelor's degree from Princeton and a law degree from the University of Virginia.

Winston Hickox, Partner, California Strategies, LLC
www.calstrat.com

Winston Hickox joined California Strategies, LLC, as a Partner in 2006. He has extensive experience in environmental policy and regulation as well as public finance, including pension fund investment management. His state environmental policy experience includes 5 years as Secretary of the California Environmental Protection Agency (CalEPA); 7 years as a Special Assistant for Environmental Affairs to California Governor Jerry Brown; and 2 years as an alternate to the California Coastal Commission, appointed by the California Speaker of the Assembly.

Mr. Hickox recently completed a 2-year assignment with the California Public Employees' Retirement System (CalPERS) Investment Office where he assisted with the design and implementation of a series of Environmental Investment Initiatives in the Private Equity, Real Estate, Global Public Equity, as well as Corporate Governance segments of the fund's $211 billion investment portfolio. In 2004, he was elected to the boards of Audubon California and Sustainable Conservation. In 1998, the Sacramento County Board of Supervisors appointed him to the Board of the $5 billion Sacramento County Employees' Retirement System (SCERS); he was recently appointed to another 3-year term.

From 1987 to 1996, Mr. Hickox was a Managing Director and Partner with LaSalle Investment Management, a major force in the world's real estate capital markets, and at that time the largest manager of CalPERS real estate assets.

Kef Kasdin, General Partner, Battelle Ventures
www.battelleventures.com

Kef Kasdin is a General Partner at Battelle Ventures and Innovation Valley Partners, where she focuses primarily on investments in communications and emerging energy technologies. She currently serves on the Boards of Directors of Aldis, Inc.; Multispectral Imaging, Inc.; Planar Energy Devices, Inc.; and Rajant Corp.

Ms. Kasdin has been involved in developing and executing strategy for high-technology companies for more than 20 years. In the 1990s, she held a number of positions of increasing importance at 3Com Corporation in Santa Clara, California. Among the titles she held at 3Com were: Vice President of Marketing, Desktop Products Division and Vice President and General Manager of the $1-billion Ethernet Products Division. In the fall of 1998, Ms. Kasdin was named 3Com's first Executive in Residence, Office of the Chairman, driving key strategic and operational initiatives for the company.

At the close of the decade, Ms. Kasdin moved to New Jersey and was a business and marketing consultant to a dozen technology start-ups. One of her key clients was Sarnoff Corporation, where she worked closely with senior executives to identify spinout opportunities and areas for future investment.

Early in her career, Ms. Kasdin was a consultant with Booz, Allen and Hamilton in San Francisco, California. She received a B.S.E degree in Operations Research from Princeton University in 1985, and an M.B.A. from the Graduate School of Business, Stanford University, in 1989.

Eric McAfee, Managing Director, Cagan McAfee Capital Partners
www.cmcp.com

Eric McAfee is an entrepreneur, venture capitalist, and merchant banker, who has founded 11 companies in renewable energy, oil and gas, networking, and software. During the past 9 years, he has invested in more than 20 companies through Berg McAfee Companies, a holding company. Mr. McAfee is the founding shareholder of six companies that were taken public, and also took five of the Cagan McAfee portfolio companies public via merger. The aggregate value of public companies Mr. McAfee has founded or participated in building is in excess of $4 billion measured by combined high market capitalizations.

AE Biofuels is an example of Mr. McAfee's involvement in clean technology development. He is the Founder, Executive Chairman, and former Chief Executive Officer of AE Biofuels, an ethanol and biodiesel company focused on the development of 2 billion gallons of ethanol production in Nebraska and Illinois, and 800 million gallons of biodiesel production in the United States and India. AE Biofuels was founded by Mr. McAfee in 2005 and taken public in mid-2006.

In 1986, Mr. McAfee graduated as the Dean's Medalist from the Fresno State University (FSU) Business School. He lectured as the 2001 Entrepreneur-in-Residence at FSU and earned the Business School Alumni of the Year Award in 2002. Mr. McAfee is a 1993 graduate of the Stanford Graduate School of Business Executive Program, and completed the Harvard Business School Private Equity and Venture Capital Program.

Chuck McDermott, General Partner, RockPort Capital Partners
www.rockportcap.com

Chuck McDermott began working in the energy and environmental area in 1984, when he joined Citizens Energy Corporation as Manager of Project Development, helping to pioneer the creation of the nation's first bulk electric power trading company. He later served as Campaign Director and then as Chief of Staff for a U.S. Congressman from 1986-1990, directing all political, constituent, and legislative matters. In 1990, Mr. McDermott joined the government relations staff of Waste Management, Inc., the world's largest environmental services company, and was made Vice President and Corporate Officer in 1993 responsible for the company's federal advocacy before the White House, U.S. Congress, and federal agencies. He relocated to Boston in 1998, and helped form RockPort's Merchant Bank in that year and the venture fund in 2001.

He currently serves on the Boards of Directors of Advanced Electron Beams, Renaissance Lighting, Soliant Energy, and Tioga Energy. He also is a Member of the Board of Directors and President of the Coalition to Advance Sustainable Technologies, a member of the Board of Advisors to the Cleantech Venture Network, Chairman of the Gridwise Alliance, and Board Member of the Flax Trust, a business incubator in Belfast, Northern Ireland.

Mr. McDermott studied at Yale University before becoming a producer, performer, writer, and music company executive, recording three albums, and founding Homecoming Records with John Stewart in 1982.

William Reilly, Founding Partner, Aqua International Partners
www.texaspacificgroup.com

William K. Reilly is a Founding Partner of Aqua International Partners, LP, a private equity fund dedicated to investing in companies engaged in water and renewable energy, and a Senior Advisor to TPG Capital, LP, an international investment partnership. Mr. Reilly served as the first Payne Visiting Professor at Stanford University (1993-1994), Administrator of the U.S. Environmental Protection Agency (1989-1993), President of the World Wildlife Fund (1985-1989), President of The Conservation Foundation (1973-1989), and Director of the Rockefeller Task Force on Land Use and Urban Growth from (1972-1973). He was head of the U.S. delegation to the United Nations Earth Summit at Rio in 1992.

Mr. Reilly is Chairman Emeritus of the Board of the World Wildlife Fund, Co-Chair of the National Commission on Energy Policy, Chair of the Advisory Board for the Nicholas Institute for Environmental Policy Solutions at Duke University, Chair of the Board for the Global Water Challenge, and a Director of the Packard Foundation, the American Academy in Rome, and the National Geographic Society. He also serves on the Board of Directors of DuPont, ConocoPhillips, and Royal Caribbean International. In 2007, Mr. Reilly was elected to the American Academy of Arts and Sciences. He holds a B.A. degree from Yale University, a J.D. from Harvard, and an M.S. in Urban Planning from Columbia University.

Rosemary Ripley, NGEN Partners
www.ngenpartners.com

Rosemary Ripley was asked to be a Member of NGEN in 2007. She joined NGEN as an Entrepreneur-in-Residence in 2006 and shortly thereafter joined the Board of EnviroTower. Ms. Ripley brings to NGEN substantial experience in strategic planning, acquisitions, and public and private market transactions. Responsible for corporate business development at Altria Group (previously Philip Morris Companies) from 1990-2005, Ms. Ripley helped spearhead and execute numerous expansionary growth plans for the operating companies. She led teams that invested heavily in Central and Eastern Europe and Asia and transformed Kraft Foods with the $19 billion acquisition of Nabisco and subsequent $8.5 billion initial public offering. Ms. Ripley also developed the strategy and led the transformation of Miller Brewing Company from a domestic business to part of an international enterprise with the merger with South African Breweries.

Prior to joining Altria, Ms. Ripley was a Managing Director at Furman Selz, responsible for the Retail and Consumer Group, and prior to that she was a Senior Investment Banker at L.F. Rothschild, Unterberg, Towbin, where she also ran the Retail and Consumer Group.

Ms. Ripley has been an active individual investor for years and co-founded Circle Financial Group, a multi-family office in 2004. Ms. Ripley received both her B.A., cum laude, and M.B.A. at Yale University.

Appendix D: Pre-Interview Instrument

Background & Purpose of the Study

The U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) wants to open communication with the investment community. Through this communication, EPA wants to get its advice on actions the Agency and the investment community could take and partnerships they could create to achieve greater private sector investment in the commercialization of environmental technologies (ET) over the long-term.

EPA has charged the National Advisory Council for Environmental Policy and Technology (NACEPT) through its Subcommittee on Environmental Technology to create a Work Group to carry out a Venture Capital Study. The Subcommittee has previously submitted to the Agency two reports—*EPA Technology Programs and Intra-Agency Coordination* (May 2006) and *EPA Technology Programs: Engaging the Marketplace* (May 2007), which may be viewed at www.epa.gov/etop. One of the key findings of the first report was that EPA has no programs specifically directed at commercialization of innovative technologies. One of the main recommendations of the second report was that EPA should partner with the venture capital community to increase private sector investment in the commercialization of environmental technology. ORD is seeking guidance for that effort through this Venture Capital Study.

Process

1. The following pre-interview instrument is divided into four parts: A. Current Investment Practices; B. Future Investment Outlook; C. EPA Activities; and D. Open-ended Questions. At least 3 days before the interview, we are asking each interviewee to rate items identified under Parts A, B, and C and return these ratings by e-mail or by fax to Andy Paterson, Econergy (contact information provided in #5 below). Part D. Open-ended Questions are offered as guides to identify the areas that will be discussed during the telephone interview.

2. We realize that you may have more to say in response to certain questions than others; that is okay, we will concentrate on the ones where you are most knowledgeable. Feel free to tell us if we have missed important issues that we should discuss with you.

3. We will make rough transcriptions of each interview. These will be for use only by members of the Work Group. You will not be directly quoted in the Work Group report.

4. We will give you an opportunity to review the Work Group's report to see if your views are accurately reflected; however, the report must be submitted to the Subcommittee before March 31, 2008.

5. If you have any thoughts, questions, or useful information for us before or after the interview, please contact Andrew Paterson (Econergy) at TEL: (202) 822-4980; FAX: (202) 822-4986; E-mail: adpaterson@econergy.com or the EPA ORD Work Assignment Manager for this project, Paul Shapiro (EPA/ORD) at TEL: (202) 343-9801; E-mail: shapiro.paul@epa.gov.

Interviewee:
Name: _____Fund/Firm: _____
HQ Locale: _____Phone: _____
Capital Under Mgmt: $ _____ million Capital Available to Invest: $ _____ million

A. Current Investment Practices[1]

ID # _____

1. Overall "Attractiveness" of Environmental Technology (ET) Market Segments

Rate overall "attractiveness" for each area according to the following scale: 1 = not attractive at all; would sell out of it, and would not recommend pursuing this sector to others; 2 = not as attractive as other segments; not pursuing; 3 = simply on par with other technology segments we are reviewing; 4 = attractive niche; distinctive market and competitive traits for venture investment; 5 = very attractive segment; actively reviewing and seeking investments

Rate: General ET segments (rate "attractiveness" based on scale above)

___ Monitoring and assessment technologies
___ Pollution prevention and control
___ Remediation and restoration technologies
___ Renewable or clean energy technologies and systems

Rate: Cleantech ET subsegments, excluding energy (rate based on scale above):

___ Agriculture (i.e., natural pesticides, land management, and aquaculture)
___ Air pollution control (cleanup, emissions control, monitoring – SOx, NOx, Hg, PM)
___ Low carbon projects, carbon offsets, monitoring technology for CO2, greenhouse gases (GHGs)
___ Manufacturing and industrial (advanced packaging, smart or "green" production)
___ Materials and industrial efficiency (i.e., "nanotech", biomaterials, chemicals)
___ Recycling and hazardous or solid waste treatment
___ Water & wastewater (water treatment, conservation, and wastewater treatment).

2. Factors Affecting Attractiveness of Environmental Technology Segments

Rate using: 1 = strongly Disagree; 2=disagree; 3=maybe; 4=agree; 5=strongly Agree
Note: Factors affecting attractiveness are stated in a *negative* voice because the premise of the survey is that environmental technologies historically have failed to garner significant levels of investment.

Technology Factors / Challenges

___ Venture capital investment in ET (versus "clean energy") lags its potential.
___ The EPA R&D budget is not at a level that can move ET to market effectively.
___ Private industry funding of R&D in ET is inadequate, limiting innovative potential.
___ Interaction between private industry and government environmental R&D programs and EPA Labs for commercializing ET must be improved (e.g., more resources, better focus, etc.).
___ The rigor of intellectual property protection in ET, in general, lags other technology areas.
___ Linkage between industry and permitting is weak.

[1] Examples of cleantech or clean technologies that include both environmental and energy technology segments are attached. This definition was created by the Cleantech Group, LLC.

___ Third-party verification programs, such as the EPA ORD Environmental Technology Verification Program, do not provide information or results that are valuable enough to affect investment decisions.
___ Engineering firms as users of ET lack real incentives to promote adoption of new technology.
___ ET lacks a level of "technology breakthroughs" that merit venture investment attention.

Market Factors / Challenges
___ Market growth for ET is low or less attractive than other venture technology sectors.
___ Market growth for ET is lower or less attractive relative to renewable energy deals.
___ While markets for upgrading water infrastructure and treatment might be promising, public and private spending is not growing fast enough for venture financing.
___ Water treatment plants as customers are "risk-averse" toward new technologies.
___ Remediation / waste management are low growth sectors with low margins.
___ Management teams in ET business plans generally lack experience, especially in marketing and manufacturing expertise, and for managing growth of new technology ventures.
___ Investment exit strategy for ET is more difficult than energy-related Cleantech segments.

Regulatory & Policy Factors / Challenges
___ A lack of new environmental legislation (e.g., Clean Air Act, RCRA) limits upside growth.
___ EPA's budget has been declining since 2004, reducing resources for enforcement, which in turn has muted market growth for ET.
___ Big equipment makers and engineering firms hamper the pace of ET adoption by favoring traditional, proven technologies over innovative ET.
___ Climate change legislation still has not been enacted, so it is not a driver yet.
___ Climate change legislation, if it occurs in the next five years, will provide more stimulus for renewable energy than ET (list above). (i.e., Of dollars invested in Cleantech, more will go into energy than into ET.)
___ Lack of familiarity with applications of ET technologies by federal / state regulators hinders use.
___ Other: _____

B. Future Investment Outlook (next 3 years)

1. Which of the following ET subsectors do you expect to invest in over the next 3 years?

Rate each one for "High" (5), "Medium" (3) or "Low" (1) level of investment compared to the total amount of investment your firm expects to be making over the next 3 years.

General ET segments (rate based on scale above):
___ Monitoring and assessment technologies
___ Pollution prevention and control
___ Remediation and restoration technologies
___ Renewable or clean energy technologies and systems

Cleantech ET subsegments, excluding energy (rate based on scale above):

___ Agriculture (i.e., natural pesticides, land management, and aquaculture)
___ Air pollution control (cleanup, emissions control, monitoring – Sox, NOx, Hg, PM)
___ Low carbon projects, carbon offsets, monitoring technology for CO2, GHGs
___ Manufacturing and industrial (advanced packaging, smart or "green" production)
___ Materials and industrial efficiency (i.e., "nanotech", biomaterials, chemicals)
___ Recycling and hazardous or solid waste treatment
___ Water & wastewater (water treatment, conservation, and wastewater treatment).

2. Which of the following might best promote market use or adoption of ET?

(Rate all on 1 to 5 scale, where 5 = "best", 3 = "some impact" and 1 = "least impact")

___ Voluntary educational campaigns for wider use of technologies (e.g., EPA, state outreach)
___ Corporate environmental commitments (voluntary or share-holder driven)
___ Expedited permitting, verification programs, or ISO Standards. for innovative ETs
___ Federal mandates, e.g., appliance standards, fuel requirements, water treatment regulations
___ Government purchasing programs for innovative "green" technologies
___ Federal agency funded R&D/Demos, followed by technology transfer programs with industry
___ Government grants to ET technology firms for innovative devices (SBIR, R&D contracts)
___ Revolving loans, credit support (lower interest rates) for systems that employ ETs
___ Subsidies for investment, e.g., Investment Tax Credits, accelerated depreciation, R&D tax credits
___ Federal subsidies for innovative technology performance, e.g., production tax credits
___ Taxes on traditional usage, e.g., taxes on fossil fuels or GHGs, increased water rates
___ International collaboration programs in ET

C. EPA Activities

Which of the following EPA programs, policies or actions provide value added information for ET investment decisions?

(Rate all on 1 to 5 scale, where 5 = "best", 3 = "some impact" and 1 = "least impact"

___ Programs (such as the Diesel Retrofit Technology Verification Program) that approve specific technologies for a given set of emission reduction credits?
___ Grant or other financial incentive programs that link monetary support directly to a class of technologies?
___ Reports of the performance of ET such as results of a verification or demonstration in the field in real world situations?
___ Technologies that have been through Phase I and II of the SBIR program where the technology has been peer reviewed?
___ EPA approved analytical methods?
___ Training and technical support of state regulatory personnel, consulting groups or others on what technologies are available and their efficacy?

___ Correspondence from EPA Program Offices to EPA Regions supporting the use of particular classes of technologies?
___ Rules, regulations, technical guidance documents that specify the use of selected technologies?
___ Technologies where EPA researchers have developed or helped co-develop the technology?
___ Others? Please specify.

D. Open-Ended Questions

1. What are the most important metrics used by your firm in evaluating environmental technology (ET) investments?

2. What is driving ET investment – EPA activities or Private Sector activities – or both?

3. Do you think ETs have a more difficult entry and/or exit investment strategy than other clean technologies? If so, what can be done to make it easier?

4. Are there characteristics of ET technologies and markets that need to change to attract venture investment?

5. Which ET segments (e.g., climate change, water technologies, etc.) have the greatest potential to generate investments in the next few years?

6. Are there "crossover" opportunities for certain technologies to support both ET and energy technologies?

7. What can EPA do to reduce the ET investment risks?

8. What EPA activities present significant barriers to ET investment?

9. Are there some successful technology development and commercialization programs that EPA learn from? If so, what are the programs?

10. How can EPA continue a dialogue with the investment community in the future?

Cleantech Definition

Cleantech Segment	*Cleantech Definition*
Agriculture	***Example Technologies*** Bio-based materials; farm efficiency technologies; micro-irrigation systems; bioremediation; 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; nanomaterials; composite materials; thermal regulating fibers and fabrics; environmentally friendly solvents; nanotechnology components for electronics, sensor applications, and energy storage; electrochromic glass; thermoelectric materials.
Energy	***Energy Generation*** Distributed and renewable energy generation and conversion, including wind, solar/photovoltaic, 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 and ion exchange systems); sensors and automation systems; water utility sub-metering technology desalination equipment.

Source: Jones, et al., 2007 and Parker, et al., 2007

Appendix E: Open-Ended Questions and Sub-Questions

Venture Capital Study – Interview Instrument

NOTE: These subquestions are for the interviewers' use only. These will not be sent to the interviewees prior to the interview.

1. What is your firm's approach to investments in this field? What are the most important metrics used by your firm in evaluating environmental technology (ET) investments?
   - Are there specific issues for ETs that influence investment strategies?
   - Are there transition issues for ET companies as they advance in each round?

2. What is driving ET investment—EPA activities, private sector activities, or both?
   - EPA activities such as compliance/enforcement, voluntary programs, industry partnerships, technology assessment/verification programs?
   - Private sector activities such as global competitiveness, shareholder pressures, institutional investors, sustainability, socially responsible investing?

3. Do you think ETs have a more difficult entry and/or exit investment strategy than other clean technologies? If so, what can be done to make it easier?
   - How much "draw" from institutional investors are you seeing for investment in ET?

4. Are there characteristics of ET technologies and markets that need to change to attract venture investment?
   - One frequently mentioned concern for cleantech, especially ETs, is the slow rate of market utilization and adoption. Innovative cleantech companies frequently try to sell their products upstream against competing, deeply entrenched traditional approaches.
   - Is there a fundamental deficiency inherent to ET that limits the likelihood of profitability and thus investment in this sector?
   - What are the elements of ET companies, technologies, and markets that account for less venture investing in certain years compared to investments in other categories?
   - Is the level of technology advancement in ETs sufficient to attract venture investment?

5. Which ET segments (e.g., climate change, water technologies, etc.) have the greatest potential to generate investments in the next few years?
   - You rated the following categories "high" _____. Why ?
   - What technologies should be invested in to mitigate and adapt to rapid climate change?
   - What can EPA do to work with the investment community in getting climate change-related ETs to market?
   - Have you seen increases in venture capital investments into companies in the areas of water treatment, filtration, and purification; conservation and efficiency; and wastewater treatment and reuse? If so, what do you believe has driven this sustained and increased investment?

- Are you aware of technology breakthroughs in this sector or other ET sectors that merit sustained venture capital interest?
- Why did you rate the following areas "low": _____ ?

6. Are there "crossover" opportunities for certain technologies to support both ET and energy technologies?
   - For example, combustion techniques that reduce loading of air pollutants and also improve fuel use efficiency.
   - Is there a role to play for EPA to integrate market opportunities to achieve multiple objectives?
   - Are there clean energy and environmental investment differences?

7. What can EPA do to reduce the ET investment risks?
   - Leadership in science and advocacy for technology?
   - Research and development?
   - Verification protocols?
   - Use of EPA's grant or loan (i.e., State Revolving Fund) funds to promote/pay for technologies?
   - Compliance assistance and technology promotion?

8. What EPA activities present significant barriers to ET investment?
   - Regulations specifying control technologies (Effluent Guidelines, Best Available Control Technology, New Source Performance Standards, etc.)?
   - Methods—sampling, analysis, and instrumentation?
   - Compliance assurance and enforcement?

9. Are there successful federal and/or private sector technology development and commercialization programs that EPA can learn from? Is so, what are the programs?
   - Department of Energy?
   - Department of Defense (e.g., DARPA)?
   - National Laboratories?
   - University-based technology promotion offices?
   - Small Business Administration?
   - State Departments of Commerce?
   - Consortia and/or public-private partnerships such as SEMATECH (SEmiconductor MAnufacturing TECHnology) and CalStart?
   - Do you have any examples to suggest or experiences to share?

10. How can EPA continue a dialogue with the investment community in the future?
    - Having this opportunity to interview you and other senior members of the investment community is very helpful to us. We would like to devise a way that we could continue getting this type of advice on a regular basis.
    - Would creating an advisory panel consisting of senior members of the investment community work?
    - If so, how should the membership be determined?
    - What are the best ways to have ongoing working relationships and partnerships with individuals, associations, and others?
    - Are there conferences and/or seminars where information could be shared between government and private sector representatives?

Appendix F: Summary of Pre-Interview Question Responses

Pre-Instrument Ratings (9)

The nine venture capitalists interviewed rated a series of niches and factors in the Pre-Interview Instrument. The nine interviewees were:

Rob Day, Principal–@Ventures
John DeVillars, Founder and Partner–BlueWave Strategies
Hank Habicht, Managing Partner–SAIL Venture Partners
Winston Hickox, Partner–California Strategies
Kef Kasdin, General Partner–Battelle Ventures
Eric McAfee, Managing Director–Cagan McAfee Capital Partners
Chuck McDermott, General Partner–RockPort Capital Partners
William Reilly, Founding Partner–Aqua International Partners/ Texas Pacific Group
Rosemary Ripley, Member–NGEN Partners

A summary of the interviewees' responses follows:

- **Current and Future Investment Trends for Environmental Technology Segments**—Clean energy was rated highest for current and future investment. Several high profile clean energy deals went public in 2006 and 2007, creating broader venture capital interest. EPA actions related to air emissions and water resource impacts have a direct bearing on clean energy options. Within environmental technology segments, "low carbon" projects drew the highest levels of interest given heightened prospects of legislation, while back-end remediation was seen as low growth and rated lowest.

- **Observations About Factors that Affect Investment in Environmental Technology**—There was wide agreement that EPA's research budget was not adequate relative to the challenges and opportunities at hand. There was some sense that improved industry and government laboratory interaction could lead to more technologies finding their way to the marketplace. Most interviewees view engineering firms and big equipment makers as more risk-averse to new technologies, perhaps because they are more invested in the current approaches, and there is little incentive to risk trying new approaches absent some elevated enforcement or new regulations. Likewise, POTWs (sewage treatment plants) were seen as risk-averse customers with little to gain from going beyond current regulations. Although climate change legislation could be an interesting driver, the lack of consensus on specific measures is causing uncertainty. Nevertheless, it is a heightened area for investment interest.

- **Viewpoints on Activities for Promoting Environmental Technology More Broadly—**Many investors noted that although investment deals could not be totally dependent on regulations, new mandates help form markets. Government grants and other subsidies also could help new technologies cross the proverbial "valley of death" from laboratory to commercial use. The interviewees saw taxes on conventional fuels and water as encouraging adoption of environmental technology because they would increase

the cost of conventional use patterns, and offer incentive for innovative approaches. International collaboration rated low universally, as most of the interviewees were focused domestically.

- **Reactions to EPA Activities Related to Environmental Technology**— Mirroring the notion that mandates can help create markets or demand for environmental technology, technical guidance specifying use of environmental technology was rated highest among the EPA activities. Grants (or perhaps revolving funds because of EPA budget constraints) also could be useful, perhaps for feasibility analyses. Some of the ratings of EPA activities were impacted by limited awareness of specific EPA programs and activities by some interviewees.

The responses were completed in February. The ratings and observations are presented below.

Ratings for Interviews

A. Current Investment Practices

A1. Overall "Attractiveness" of ET Market Segments

	Avg (9)
General ET segments	
Monitoring and assessment technologies	3.3
Pollution prevention and control	3.3
Remediation and restoration technologies	2.8
Renewable or clean energy technologies and systems	**4.9**
Cleantech ET subsegments, excluding energy	
Agriculture (i.e., natural pesticides, land management, aquaculture)	3.3
Air pollution control (emissions control, monitoring)	3.4
Low carbon projects, carbon offsets, monitoring for GHGs	**4.1**
Manufacturing and industrial (packaging, "green" mfg.)	3.8
Materials & efficiency ("nanotech", biomaterials, chem)	3.7
Recycling and hazardous or solid waste treatment	2.8
Water & wastewater (treatment, conservation, recycling).	3.8
Overall average	**3.6**

A1 Observations on Current Investment

Overall, renewable energy related deals have attracted the most investment. Low carbon projects were rated highest among the ET segments, perhaps because of the elevated interest in the "climate change" issues as a driver for new market niches and for growth of expenditures to curtail carbon emissions. Recycling and hazardous waste rated lowest as a back-end business that saw a lot of bankruptcies in the 1990s.Water treatment rated just higher than average, could attract more capital with better growth prospects.

A2. Factors Affecting Attractiveness of ET Segments

1 = strongly Disagree; 2=disagree; 3=maybe; 4=agree; 5=strongly Agree

	Avg (9)
Technology Factors / Challenges	
Venture capital investment in ET (vs. "clean energy") lags.	3.6
EPA R&D budget not at level that moves ET to market.	**4.4**
Industry funding of R&D in ET is inadequate, limiting innovation.	3.4
Industry - Gov't / Lab interaction on ET R&D must be improved	**4.3**
Rigor of IP protection in ET lags other technology areas.	2.8
Linkage between industry and permitting is weak.	4.0
Verification results (EPA ETV) not valuable enough	4.0
Engineering firms lack incentives to promote ET technology.	**4.2**
ET lacks a level of breakthroughs to merit venture investment.	2.8
Market Factors / Challenges	
Market growth for ET is less attractive than other sectors.	3.2
Market growth for ET is less attractive vs. renewable energy.	3.9
Water market spending not growing fast enough for venture financing.	**4.1**
Water treatment plants are "risk-averse" customers on ET.	**4.9**
Remediation / waste mgmt suffer low growth, low margins.	4.0
Mgmt teams in ET lack experience for managing growth.	3.1
Investment exit strategy for ET is more difficult than Cleantech energy.	3.9
Regulatory & Policy Factors / Challenges	
Lack of new environmental legislation limits upside growth.	
EPA's budget (down since 2004) reduces enforcement, growth for ET.	3.4
Equipment makers, engineering firms hamper ET adoption.	3.9
A climate change bill not enacted, so it is *not* a driver yet.	**4.3**
Climate change legislation (by 2012) will provide more stimulus for renewable energy than ET	3.6
Lack of familiarity with ET by regulators hinders use.	3.6
Overall average (for A2)	3.8

A2 Observations on Factor Ratings

There was wide agreement that EPA's R&D budget was not adequate relative to the challenges and opportunities at hand. Perhaps related to R&D funding is a sense that Industry and government lab interaction can be improved so that more of the R&D funding actually finds its way into the marketplace, a key issue in "bridging the gaps" to investors and industry.

Many interviews see engineering firms and big equipment makers as more risk-averse to new technologies, perhaps because they are more invested in the current approaches, and there is little incentive to risk trying new approaches absent some elevated enforcement or new regulations. Likewise, POTWs (sewage treatment plants) were seen as risk-averse.

Although climate change is an interesting driver, the lack of consensus on legislation is causing uncertainty. Still, it is a heightened area for investment interest. Regulators also need to improve their familiarity with innovative ET.

B. Future Investment Outlook (Next 3 years)

B1. Which ET subsectors do you expect to invest in (next 3 years)?

Rate each one for "High" (5), "Medium" (3) or "Low" (1) level of investment compared to total amount of investment your firm expects over the next 3 years.

General ET Segments	B1. Future Average	A1. Current Average
Monitoring and assessment technologies	3.4	3.3
Pollution prevention and control	2.7	3.3
Remediation and restoration technologies	1.9	2.8
Renewable or clean energy technologies and systems	**5.0**	**4.9**
Cleantech ET subsegments, excluding energy:		
Agriculture (i.e., natural pesticides, land management, aquaculture)	3.0	3.3
Air pollution control (emissions control, monitoring)	3.0	3.4
Low carbon projects, carbon offsets, monitoring for GHGs	**4.3**	**4.1**
Manufacturing and industrial (packaging, "green" mfg.)	3.0	3.8
Materials & efficiency ("nanotech", biomaterials, chem)	3.6	3.7
Recycling and hazardous or solid waste treatment	2.0	2.8
Water & wastewater (treatment, conservation, recycling).	3.2	3.8
Overall average (for B1)	**3.2**	**3.6**

B1 Observations on Future Investment

Energy related deals will continue to attract more investment, while remediation has become less attractive as a market that has plateaued, and one where technology is not seen to be as applicable to a high growth niche. Low carbon projects were rated high across the board based on broader market activity. Manufacturing or industrial packaging fell in attractiveness going forward.

B2. Which might best promote market use or adoption of ET?

(Rate all on 1 to 5 scale, where 5 = "best", 3 = "some impact" and 1 = "least impact")

	Avg (9)
Voluntary educational campaigns for use of ET (e.g., EPA, state outreach)	2.7
Corporate environmental commitments (voluntary or share-holder driven)	3.7
Expedited permitting, verification programs, or ISO Standards. for ET	**4.1**
Federal mandates: appliance standards, fuel regulations, water regulations	**4.7**
Government purchasing programs for innovative "green" technologies	3.9
Federal agency funded R&D/Demos, technology transfer with industry	**4.2**
Government grants to ET firms for innovative devices (SBIR, R&D)	**4.4**

	Avg (9)
Revolving loans, credit support (lower interest rates) for systems with ET	3.9
Subsidies for investment, e.g., Investment Tax Credits, depreciation	**4.6**
Federal subsidies for technology performance, e.g., production tax credits	**4.7**
Taxes on traditional usage, e.g., taxes on fossil fuels or GHGs, water use	**4.9**
International collaboration programs in ET	2.1
Overall average (for B2)	4.0

B2 Observations on Promotion of Environmental Technology

Many investors noted that while deals could not be totally dependent on regulations, new mandates help form markets. Government grants and other subsidies could also help new technologies cross the proverbial "valley of death" from lab to commercial use. All saw taxes on conventional fuels and water as encouraging adoption of ET. International collaboration rated low universally, as most were focused domestically.

C. EPA Activities

Which of the following EPA programs, policies, or actions provide value added information for ET investment decisions?

(Rate all on 1 to 5 scale, where 5 = "best", 3 = "some impact" and 1 = "least impact")

	Avg (9)
Programs approving specific technologies for emission reductions	3.9
Grant or other incentives to directly fund a class of technologies	3.9
Reports of ET field performance (verification or demonstration)	3.4
Technology peer review (after Phase I and II of SBIR program)	3.6
EPA approved analytical methods	2.9
Training and technical support of state regulatory personnel, consultants	3.3
Correspondence from EPA Program Offices to EPA Regions for ET	3.0
Rules, regulations, technical guidance specifying use of selected ET	4.0
Info on technologies from EPA researchers	2.8
Overall average (for C)	3.4

C Observations on EPA Activities

Mirroring the notion that mandates can help create markets or demand for ET, technical guidance specifying use of ET was rated highest among EPA activities. Grants could also be useful, perhaps for feasibility analysis. Some of the ratings of EPA activities were muted by incomplete awareness of EPA programs and activities by some interviewees.

Appendix G: Examples of Successful Investments from the Venture Capital Community

The venture capitalists interviewed provided a number of examples of successful investments in environmental technology. This appendix contains a selection of these examples to provide some idea of the range and type of investments that have been and can be made by the venture capital community.

Advanced Electron Beam

www.aeb.com

"Funding New Technology That Holds Promise for a Cleaner Environment"

RockPort Capital Partners

Advanced Electron Beam (AEB), a Wilmington, Massachusetts company, has developed a breakthrough electron beam technology—the AEB Emitter—that is 10 times less expensive and 100 times more compact in size than conventional electron beam units. While electron beams have historically been used in industrial applications to replace chemical and thermal processes, adoption has been limited because of high equipment and operating costs, complex implementation, and the huge size of conventional electron beam technologies. By contrast, the AEB Emitter makes it possible to integrate this clean energy source into a wide array of applications that was never before technically or economically feasible.

The small size of AEB Emitters allows electron beams to be easily integrated "in line" into existing manufacturing and production equipment, bringing the beam to the production line for maximum process efficiency. Available in 10-inch and 16-inch models, AEB Emitters can be aligned in multiples to produce a beam of any desired width and are small enough to be directed at any angle. Additional geometries to increase coverage area, electron dose and process throughput also are possible. AEB Emitters have an operating voltage of 80-150 kV and weigh less than 30 pounds. Moreover, the approach requires no active vacuum pumping equipment, offers a compact, solid-state power supply, and requires no in-plant engineering or maintenance expertise.

AEB Emitters offer the opportunity for a variety of manufacturers to transform their production processes. Many companies in large industries are very interested in reducing manufacturing costs, saving energy, and eliminating pollution and those are the benefits offered by this new technology. AEB Emitters can address a range of applications across the sterilization, pollution abatement, and curing and polymer treatment sectors. Specific AEB Emitter applications include: the destruction of airborne viruses and bacteria; the extension of shelf life of foods; generation of hydrogen for fuel-cell vehicles; the modification of recycled tires into high-quality engineered plastics; and the removal of hazardous gases, such as sulfur and nitrous oxides (SO_X/NO_X), from fossil-fuel burning power plants.

In March 2007, Advanced Electron Beam announced it has received $17.5 million in a Series B funding round led by RockPort Capital Partners, with participation from existing investors Atlas Venture and General Catalyst Partners. The funding will be used to accelerate AEB's efforts to commercialize its AEB Emitters as

one of the world's most efficient, clean, and cost-effective forms of industrial energy. A RockPort Capital General Partner serves on the Board of Directors of Advanced Electron Beam.

AE Biofuels

www.aebiofuels.com

"New Ethanol Production Technology Responds to Energy and Environmental Legislation"

Cagan McAfee Capital Partners

AE Biofuels, Inc., Cupertino, California, is an advanced energy company that has constructed and is developing next-generation ethanol and biodiesel production worldwide. AE Biofuels is seeking to become the first independent vertically integrated biofuels company in the world. The company is developing biofuels production from both nonfood and traditional materials. AE Biofuels has a new cellulosic ethanol plant in Montana, three biodiesel plants operating or planned in India, and six U.S. ethanol plants—five plants in Illinois and one plant in Nebraska.

On December 19, 2007, President Bush signed the Energy Independence and Security Act of 2007 (EISA, Public Law 110-140). This new law covers a wide range of energy topics with extensive attention to biofuels, including ethanol and biodiesel. Key biofuels-related provisions include: a major expansion of the renewable fuel standard (RFS) established in the Energy Policy Act of 2005 (EPAct) expansion and/or modification of tax credits for alternative fuel refueling infrastructure, and for ethanol and renewable diesel fuels; grants and loan guarantees for biofuels research, development, deployment, and production; studies of the potential for ethanol pipeline transportation, expanded biofuel use, market and environmental impacts of increased biofuel use, and the effects of biodiesel on engines; and reauthorization of biofuels research and development at the U.S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA).

Title II of EISA requires a dramatic expansion of the RFS under EPAct 2005. Instead of the 5.4 billion gallons required in 2008 by the EPAct, EISA requires 9.0 billion gallons. By 2022, EISA will require 36 billion gallons of renewable fuel in motor fuels annually, compared to an estimated 8.6 billion gallons under the EPAct. Of that, 21 billion gallons must be "advanced biofuel," defined as biofuel produced from feedstocks other than corn starch and having 50 percent lower lifecycle emissions than petroleum fuels. Advanced Biofuel has three different subcategories: cellulosic biofuel, biomass-based diesel, and other.

On February 7, 2008, EPA published new RFS regulations to comply with the EISA 2008 provision for 9 billion gallons of ethanol use. The new RFS is 7.76 percent ethanol in gasoline for 2008. Section 211 of the Clean Air Act (CAA), as amended by EISA, requires EPA to annually determine an RFS that is applicable to refiners, importers, and certain blenders of gasoline, and publish the standard in the *Federal Register*. This standard is calculated as a percentage, by dividing the amount of renewable fuel that the Act requires to be blended into gasoline for a given year by the amount of gasoline expected to be used during that year. EPA originally set the RFS for 2008 at 4.66 percent based on the RFS requirement of 5.4 billion gallons in 2008 in the EPAct of 2005.

In February 2008, AE Biofuels, announced the construction of an integrated cellulose and starch ethanol commercial demonstration facility in Butte, Montana. The plant will use the company's proven patent-pending Ambient Temperature Starch Hydrolysis (ATSH) enzyme technology to optimize process conditions for multiple feedstocks. Nonfood ethanol feedstocks used by the facility are expected to include switch grass, grass seed straw, small grain straw, and corn stalks alone and in combination with a variety of traditional starch and sugar sources. The 9,000 square-foot pilot plant facility is expected to be fully operational in the second calendar quarter of 2008.

The AE Biofuels technology significantly reduces the consumption of energy and water in the production of ethanol, and allows the use of a combination of nonfood and traditional feedstock inputs. Applications of the ATSH enzyme technology also may include licensing or joint ventures with sugar cane ethanol plants.

AE Biofuels is supported by Cagan McAfee Capital Partners, a Silicon Valley-based venture capital organization. Eric McAfee, Managing Director, Cagan McAfee Capital Partners, also is the Chairman and Chief Executive Officer of AE Biofuels, Inc.

Aldis, Inc. and Planar Energy Devices

www.aldiscorp.com and www.planarenergy.com

"Technology 'Spinouts' from Government Laboratories"

Battelle Ventures

Battelle Ventures, LP, and its affiliate fund, Innovation Valley Partners (IVP), have committed nearly $8 million in start-up financing to two energy-related companies, Aldis, Inc., and Planar Energy Devices, Inc., which are direct spinouts of the U.S. Department of Energy's national laboratories managed by Battelle Ventures' sole limited partner, Battelle Memorial Institute (Battelle).

Aldis, a traffic management technology company focused on energy efficiency, has a joint development agreement with Oak Ridge National Laboratory (ORNL), and Planar Energy Devices (Planar), a power-storage company developing thin-film batteries, is a spinout of DOE's National Renewable Energy Laboratory (NREL), as well as a licensee of both NREL and ORNL technology.

Aldis and Planar are examples of how Battelle Ventures has acted as "founder capitalists," building technology companies from the ground up. With Battelle as a limited partner, Battelle Ventures cannot only deploy a unique set of company-building capabilities, but it also can leverage its position as a bridge between early-stage businesses or technology entrepreneurs and the Battelle network to add value to Battelle Ventures' portfolio companies.

Battelle Ventures investments in Aldis and Planar unfolded differently. For Aldis, assurances of the management team capability came before the technology. The idea for advanced traffic management came from the Aldis cofounders, who Battelle Ventures took to visit ORNL, where some related projects were in development.

Battelle Ventures became aware of the differentiated power-storage technology created at NREL, which became the basis for Planar. Battelle Ventures funded early prototype development of the technology and recruited Planar's Chief Executive Officer for the spinout. Planar then was introduced to complementary work going on at ORNL in the thin-film battery area and, as a result, became a licensee of ORNL technology as well.

M2E Power

www.m2epower.com

"Utilizing CRADAs to Demonstrate and Commercialize Innovative Technologies"

@Ventures

M2E Power, Inc., a Boise, Idaho company, has developed a micro-generator that converts everyday human and vehicle motion into enough energy to power mobile electronic devices. The company expects its technology—an advance on the technology found in devices like self-winding watches and battery-free flashlights—will eventually power cell phones, digital cameras, and portable entertainment players. For now, however, the company is focusing on powering mobile devices on the battlefield.

The patent-pending M2E™ (Motion to Energy) technology originated with Department of Energy-funded research at the Idaho National Laboratory (INL). Inventor Eric Yarger and his team at the INL sought to ease the military's battery dependence for mobile power and offer soldiers a way to generate power as they move around. It leverages the well-proven Faraday Principle (energy produced via motion of a magnet through a wire coil), but with changes in the magnetic architecture that have broad applicability to many sizes of motor generators.

In November 16, 2007, @Ventures, the clean technology venture capital business of CMGI®, Inc., announced that it made a $2.0 million investment in M2E Power, Inc. @Ventures participated in the company's $8 million Series A financing round, along with OVP Venture Partners, Highway 12 Ventures and existing investors.

M2E Power will use the funds to speed commercialization of its M2E™ technology, which has the potential to fundamentally transform the way military and consumer mobile devices are powered. M2E also may provide significant economic benefits for larger-scale generator applications such as wind and ocean wave power.

M2E also is an eco-friendly, cleantech solution that can significantly reduce carbon emissions in larger applications. Depending on usage, it may not need to draw from power grids to recharge itself. It eliminates up to 30 percent of the highly toxic heavy metal contained in typical batteries and—by doubling battery life—cuts in half the number of batteries discarded in landfills.

ORYXE Energy International and WaterHealth International

www.oryxe-energy.com and www.waterhealth.com

"Technology Verification Validates Innovative Environmental Technology Claims"

SAIL Venture Partners

ORYXE Energy and WaterHealth International (WHI), both in Irvine, California, have developed patented environmental technologies that are addressing unique environmental problems. ORYXE Energy has developed a breakthrough additive, ORYXE™ RFT, to improve efficiency and reduce harmful emissions in residual oil-fired boilers and process heaters. WHI developed a low cost, ultraviolet water disinfection device, the UV Waterworks™ (UVW), which was invented to address the needs of underserved communities around the world. Both patented technologies have been subjected to air and water pollution testing procedures developed by EPA to validate their pollutant reductions claims.

Testing has proven that ORYXE RFT provides significant reductions in particulate matter emissions while keeping NO_X neutral and improving furnace heat transfer. Residual oil-fired plants experience reduced black smoke emissions from their exhaust stacks and improved overall efficiency with the use of ORYXE RFT. The efficiency improvement often offsets the cost of the additive, thus providing users with an emission reduction program that requires no large capital expense and little to no operational expense.

Dr. Ashok Gadgil, Vice President of Scientific Affairs for WHI, developed UVW at the DOE Lawrence Berkeley National Laboratory. Through a multi-stage filtration process coupled with a proprietary ultraviolet disinfection technology, contaminated water is converted into clean, potable water that exceeds the World Health Organization's standards for potable water. The UVW-based system effectively purifies and disinfects water contaminated with a broad range of pathogens, including polio and roto viruses, oocysts, such as *Cryptosporidium* and *Giardia*. Low maintenance requirements, high efficiency, and high throughput make UVW systems capable of delivering affordable, high-quality drinking water even to remote and rural markets that have previously been under served.

ORYXE Energy's new technology already has been proven to reduce emissions in diesel fuel. The technology was used to develop an alternative diesel formulation, approved by the Texas Commission on Environmental Quality, to meet the new Low Emission Diesel standards in Texas. The immediate success of this product, called ORYXE LED, also proves ORYXE Energy's ability to meet its promise to supply a revolutionary new additive to the market.

Pacific Ethanol

www.pacificethanol.net

"Time to Market for Clean Technologies is Essential"

Cagan McAfee Capital Partners

Pacific Ethanol, Inc., Fresno, California, is the largest Western United States marketer and producer of ethanol. The company was founded in 2003, and by 2006, it was worth $1.8 billion, and publicly traded. Pacific Ethanol has operational ethanol plants in Madera, California, and Boardman, Oregon, and has two additional plants under construction in Burley, Idaho, and in Stockton, California. Pacific Ethanol also owns a 42 percent interest in Front Range Energy, LLC, which owns an ethanol plant in Windsor, Colorado. From these facilities, Pacific Ethanol's goal is to achieve 220 million gallons per year of ethanol production capacity in 2008, and to increase total production capacity to 420 million gallons per year in 2010.

In February 2006, *Fortune Magazine* called Pacific Ethanol the only publicly traded pure-play ethanol maker and commended the company for its ability to raise a private equity total of $111 million, including $84 million from Bill Gates. Based on DOE estimates, *Fortune* predicted that, by 2030, ethanol could replace up to 30 percent of the projected gasoline usage at that time.

On December 19, 2007, President Bush signed the Energy Independence and Security Act of 2007 (EISA, Public Law 110-140). This new law covers a wide range of energy topics with extensive attention to biofuels, including ethanol and biodiesel. By 2022, EISA will require 36 billion gallons of renewable fuel in motor fuels annually, compared to an estimated 8.6 billion gallons under the former Energy Policy Act. Of this 36 billion gallon requirement, 21 billion gallons must be "advanced biofuel," defined as biofuel produced from feedstocks other than corn starch and having 50 percent lower lifecycle emissions than petroleum fuels.

In January 28, 2008, the U.S. Department of Energy announced that Pacific Ethanol would receive a matching grant award totaling $24.32 million to build the first cellulosic ethanol demonstration plant in the Northwest United States. The pilot plant is designed to produce 2.7 million gallons of ethanol annually. The plant will employ a technology to produce ethanol from wheat straw, wood chips, and corn stover and will be co-located at the site of Pacific Ethanol's existing corn-based ethanol facility in Boardman, Oregon. Pacific Ethanol's partners in winning this competitive process were, BioGasol ApS and the Joint BioEnergy Institute (a consortium of academic institutions and DOE laboratories including the Lawrence Berkeley National Laboratory and Sandia National Laboratory). BioGasol ApS has developed the proprietary technology and the Joint BioEnergy Institute will be providing support and specific research and development on enzyme technology.

The two principal founders of Pacific Ethanol were Eric McAfee, Cagan McAfee Capital Partners, and Bill Jones, former Secretary for the California Environmental Protection Agency.

Sensicore

www.sensicore.com

"ETV Evaluates the Sensicore 'Lab-on-Chip' Water Testing Technology"

NGEN Partners

Sensicore, an Ann Arbor, Michigan company, manufactures smart sensors and sensor networks that automate water testing, data collection, and analysis for both drinking and industrial applications.

The Sensicore Water Point 870 (WP 870), lab-on-chip micro-sensor array technology, is used to chemically profile drinking water (and/or other liquids) for municipal and industrial applications. This hand-held system is capable of measuring and calculating 19 different water parameters in 6 minutes. Key water quality tests that the WP 870 can perform include measurements for pH, Free Chlorine, Total Chlorine, Ammonia, Total Dissolved Solids, Calcium Hardness, and other water parameters. The Water Point system enables municipalities and industrial customers to monitor their water in real-time, helps them pinpoint the extent of contamination quickly and efficiently, and allows users to perform post-event monitoring while still the field.

From April through July 2007, the WP870 was tested by the EPA Environmental Technology Verification (ETV) Program evaluating the following parameters: accuracy—comparison to results from standard laboratory water reference analyses; precision—repeatability from sample replicates analyzed on the same day; inter-unit reproducibility—comparison of results from two identical sensors and handheld units; field portability—operation during remote field site analysis; and ease of use—general operation, data acquisition, set-up, consumables used, and purchase and operational costs. In September 2007, EPA released its ETV Report on the Sensicore WP870. The report is available on line at http://www.epa.gov/etv/pubs/ vrSensicoreWS.pdf.

Sensicore was founded in November 2000, in partnership with researchers from the University of Michigan, to explore new applications for solid-state sensors. The initial goal was to create a means of liquid profiling that took full advantage of sensor technology and emphasized greater convenience and ease of use than traditional methods.

By the end of 2003, the company met its first major challenge with the development of a disposable micro-sensor that was cost effective and easy to replace. Based on this success, the company assembled a broader team of international water industry experts to apply sensor technology in a commercially viable product. Water POINT™, a hand-held device for point source water testing, was launched nationally in the first quarter of 2005. In March 2006, Sensicore announced the availability of the WP870, its second generation hand-held water testing system.

Sensicore is supported by a group of Venture Capital organizations including: NGEN Partners**,** Santa Barbara, California; Aridest, Ann Arbor, Michigan; Capital Management, Palo Alto, California; Technology Partners**,** Palo Alto, California; and Topspin Partners, Roslyn Heights, New York.

Soliant Energy

www.soliant-energy.com

"Using Government Grants to Augment Venture Capital Investment in Clean Technology"

RockPort Capital Partners

Soliant Energy in Pasadena, California, designs and manufactures concentrator photovoltaic modules for grid-tied and off-grid, residential and commercial uses. Soliant was founded in 2005 and aims to achieve grid-cost electricity via photovoltaic modules by 2010. Soliant's product platform, the Heliotube™ concentrating solar panel, addresses the strong market need for lower-cost, higher-power solutions for rooftop solar power.

In contrast to the other photovoltaic concentrator modules on the market today, the Heliotube panel includes concentration and solar tracking within the traditional form factor of a 4' x 6' solar panel. Heliotube's integrated tracking mechanism provides more uniform power output than traditional flat panels and eliminates the substantial efficiency losses associated with fixed low-concentration modules. In addition, the Heliotube tracking system is self powered and plug-compatible with conventional "flat plate" x-Si products. As a plug-compatible alternative to standard solar panels, Heliotube conforms to the existing standards and practices of the large, established channels of solar installers, integrators, project managers, dealers, and distributors.

In March 2007, Soliant Energy (previously Practical Instruments) was awarded a $4 million grant from the U.S. Department of Energy (DOE) Solar America Initiative (SAI). The DOE SAI grant will allow the company to accelerate development of its Heliotube™ product platform. Soliant's project partners in the SAI award included: Spectrolab, the DOE Sandia National Laboratory, SunEdison, and the Massachusetts Institute of Technology.

Soliant's DOE SAI award is expected to allow the company access to more private equity support if needed in its photovoltaic product line development. Currently, Soliant is funded by leading energy and renewable technology investors, including RockPort Capital, Trinity Ventures, Nth Power, Silicon Valley Bank, and Rincon Venture Partners. A RockPort Capital General Partner serves on the Board of Directors of Soliant Energy.

212 Resources

www.212resources.com

"Securing Long-Term Debt Financing for an Environmental Technology"

@Ventures

The focus of @Ventures' current fund, formed in 2004, is on investments in the cleantech sector, including alternative energy, energy storage and efficiency, and water purification technologies. In early 2007, @Ventures made a $3 million investment in 212 Resources (formerly H2Oil Recovery Services), a natural

resource recovery company specializing in the reclamation of valuable hydrocarbons and fresh water from oil and gas exploration and production processes.

In September 2007, @ Ventures helped 212 Resources secure a $250 million credit line from GE Financial Services to help the company expand its technology applications in the oil and gas industry.

As part of the GE Services credit, an initial $27.5 million of equipment and working capital financing will allow the company to commence processing and recycling oilfield wastewater into clean water for reuse in drilling operations at the Pinedale Anticline, the nation's second-largest natural gas field. This facility will allow the company the flexibility to expand its services to protect environmentally sensitive wilderness areas.

The 212 Resources company name reflects the "resource recovery opportunities at the boiling point of water (212°F)" and how the company focuses on helping to address one the world's most serious problems—water conservation.

The 212 Resources' well-site service enables oil and gas companies to develop reserves, reclaim and purify water, and add incremental revenue by enhancing hydrocarbon recovery. The company employs a patented vapor compression flash evaporation system that separates

wastewater generated by oil and natural gas exploration and production into clean water, brine, methanol, and natural gas condensate.

Recovering valuable byproducts, while generating clean water, allows the oil and natural gas industry to lower its water management costs. In addition to protecting fresh water aquifers in production fields, the negative environmental impacts of trucking and impounding wastewater are reduced. The company has several plants in Wyoming under construction to treat more than 9,000 barrels of water per day at different oil and gas sites.

Appendix H: Understanding the Environmental Impact of Clean Energy and Other Technology Investments: Environmental Capital Group's Environmental Due Diligence Process

Clean Energy and Technology Investments

Clean energy and technology investments include those that provide economic value while improving the sustainable use of natural resources and reducing waste and emissions as compared to existing products, services, or technologies. This includes alternative and renewable energy (clean energy), water technologies (clean water), advanced materials or nanotechnology (clean material), air purification technologies (clean air), and transitional infrastructure opportunities. Environmental Capital Group (ECG) provides environmental due diligence, performance monitoring, and reporting services that account for the real environmental impacts created by the private equity investments in clean energy and technology.

Environmental Due Diligence

The purpose of environmental due diligence is to answer two key questions:

1. If the technologies of the portfolio companies are successfully commercialized, will the fund result in significant net environmental benefits?
2. Does the fund management have the capability and willingness to implement its environmental strategy and measure the resultant environmental benefits?

Each candidate fund responds to a set of questions about the fund's potential environmental benefits, environmental strategy, prior experience in environmental investments, environmental and technical expertise, and experience and knowledge of measurement of environmental results. For a fund to be recommended, it has to meet expectations according to specific criteria in each of the following categories:

- Priority and scope of environmental problems addressed.
- Magnitude of potential environmental benefits.
- Environmental strategy of fund.
- Likely environmental performance of fund.
- Management team environmental experience.
- Environmental performance monitoring capability.

Successful Investment Proposals

The most successful investment proposals have the following characteristics:

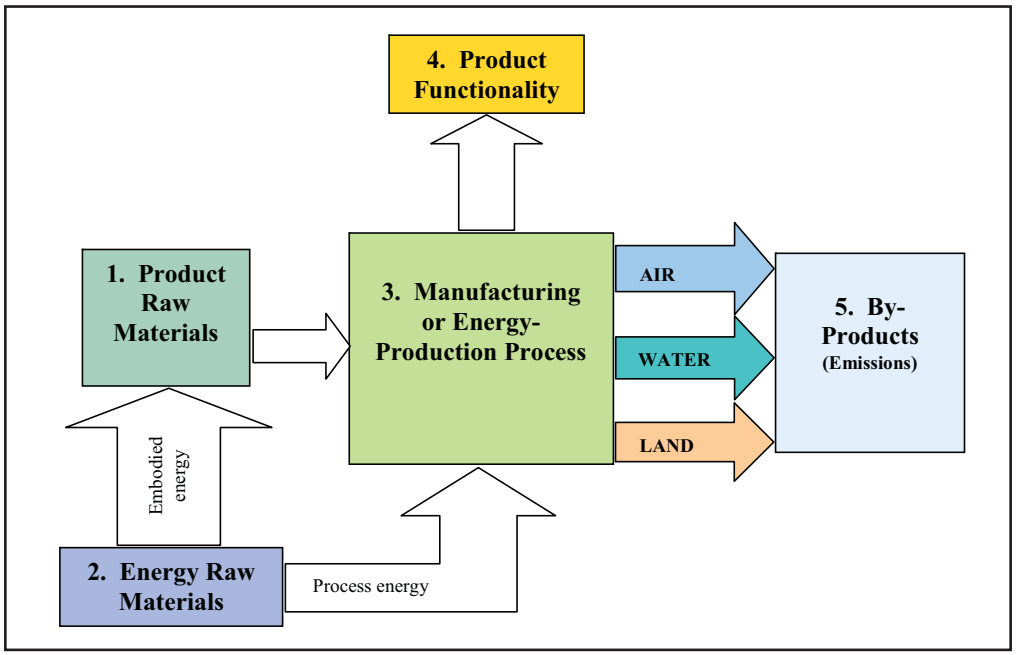
- The prospective portfolio companies are likely to result in significant environmental benefits because of the potential for breakthrough technologies and/or because the technology might be transferred to multiple companies.
- The fund management demonstrates an understanding of: a) the environmental problems that it will address, b) the importance of considering positive and negative environmental impacts, c) the legal/regulatory environment, and d) the need to have a plan to commercialize technologies to achieve actual environmental benefits.

- The proposal explicitly describes how the fund management will consider the potential environmental impact prior to selection of portfolio companies, in addition to financial considerations.

The fund management includes people with sufficient technical depth and willingness to undertake a quantitative analysis of net environmental benefits of its portfolio companies.

Net Environmental Benefits

ECG has developed analytical methods to measure and report significant net environmental benefits created by the portfolio companies. To analyze net environmental benefits, we consider how the "new" process or product compares to the "existing" process or product. This requires an understanding of not only the environmental impacts of the company's technology, but also of the technology that it seeks to replace. It also requires establishing the boundaries of the analysis and considering significant positive and negative environmental impacts within those boundaries. For example, when analyzing how an electric car benefits the environment, we must first answer the question: "Compared to what?" Usually, the comparison is made to the industry standard or typically-used product, which we call the "base case". We must then address the question of how the new technology compares environmentally to the base case, both positively and negatively. The diagram below shows potential sources of environmental benefits relating to consumption of energy and raw materials and manufacture of product and by-products.



1. ***Product Raw Materials:*** The technology may require either a smaller amount of raw material or a more environmentally benign raw material to achieve the same result compared to the industry-standard (e.g., a manufacturing process that recycles by-products to be used as raw material).
2. ***Energy Raw Materials:*** The energy used to make the raw materials (embodied energy) or to convert the raw materials to the final product (process energy) may be from a renewable energy source instead of a fossil carbon energy source (e.g., liquid fuels produced from agricultural waste).

3. ***Manufacturing or Energy-Production Process:*** The technology may improve the efficiency of a manufacturing or energy-production process so that less energy is consumed (e.g., energy storage devices that allow for load-shifting and improved efficiencies in power plants).
4. ***Product Functionality:*** The product itself may be more environmentally benign than the product it replaces (e.g., a less toxic insecticide).
5. ***By-Products (Emissions):*** The technology may result in fewer by-products or emissions (air, water, and/or land) compared to the industry-standard (e.g., a cleaner burning coal).

All five of these areas must be considered in an analysis of net environmental benefits and are usually linked. Consider solar energy as an example. The ***product functionality*** is electrical power, which is similar to that produced from traditional sources, but with significantly less ***by-products*** because the absence of combustion to produce the electricity also means the absence of greenhouse gas and other air emissions. In addition, the ***energy raw material*** (the sun) is renewable, so fossil carbon resources aren't depleted. However, the solar panels are manufactured from ***product raw materials*** that consume energy to produce (embodied energy, which may be fossil carbon based and which will vary in amount and type depending on the panel technology employed). The amount of energy produced in the ***energy-production process*** will also depend on the technology employed.

Clearly, the extent of conducting such an analysis depends upon the detail in which each area is considered (do you count the energy required to make the machinery for a manufacturing process?) and the boundaries selected for the analysis (do you count the fuel burned by the workers driving to an ethanol plant?). This process has to be mindful of the costs associated with capturing and accounting for the net environmental benefits. Toward this end, ECG considers only those elements that significantly affected the results compared to the base case, what we call the "80/20 rule". For example, for a portfolio company producing a new building insulation product from recycled materials, we included the savings in ***product raw material embodied energy*** because making the recycle-based product required at least 20% less fossil carbon-based raw materials than making the traditional material. We also included the difference in ***product functionality*** (insulating capability) because the insulating capability of the recycle-based product was at least 20% better than the traditional material, resulting in building energy savings and reducing associated air emission ***by-products***. We did not go to the detail of comparing the embodied energy of the machinery used to produce the recycle-based and traditional products. In most cases, we only considered the direct raw materials and energy used in the manufacturing process and the direct emissions from the process, not raw materials, energy and emissions further downstream or upstream. As we follow these companies over the investment period, we will continue to check if we are capturing all the material net environmental benefits.

Another example of our approach is small-scale wind-powered electricity generation. These wind turbines are sold throughout the US. We selected as a base case the production of electricity from all sources in the US (natural gas, coal, nuclear, etc.) and assumed that any power generated from the wind turbines would displace power generated from a weighted average of these sources. We then calculated the total amount of power displaced and an associated reduction in air emissions (e.g., CO_2, NO_X, SO_X, Hg) based on the weighted average emissions from all sources. This is obviously an approximation. If we could determine exactly where each wind turbine was installed, we could identify

whether it was replacing natural gas-based power or coal-based power, which have different emission profiles, but this is beyond the scope of our analysis (and data available). We also did not include the energy required to make the turbines. In other cases, such as photovoltaic-based solar power, the embodied energy in the solar panels varies significantly between technologies and is significant compared to the energy produced by the panels. As such, it is included in our calculations.

A defensible analysis of net environmental benefits must include consideration of significant negative environmental impacts. There is a difference in net greenhouse gas emissions (CO_2) between growing crops in an empty field to feed an ethanol plant and cutting down a rain forest to make room for such crops. In fact, the analysis of the net environmental impact of biofuels depends on careful consideration of each element in the model (raw materials, process energy type and requirements, end-product functionality, by-products, etc.).

Environmental Performance Reporting System

To move from concepts about environmental benefits to specific results for each portfolio company, ECG developed an Environmental Performance Reporting System (EPRS). The objectives of this system are to:

1. Measure the net environmental benefits of each fund and portfolio company investment; and
2. Establish an environmental performance basis for proactively choosing future clean energy and technology investments.

The first step in this process takes place upon the initial investment in each portfolio company. During due diligence, the General Partner of the fund identifies the significant environmental impacts of each company and determines whether they are consistent with the overall environmental objectives of the fund. Within 90 days of the initial investment, the General Partner establishes an environmental performance framework for each portfolio company, including selecting the appropriate base case and preparing a sample net environmental benefit calculation.

The calculation of net environmental benefits can be thought of as an engineering or technical report that links a business result, such as the number of product units sold or amount of material processed, to the associated environmental result, such as tons of emissions avoided or gallons of water saved. ECG works with the General Partner to conduct this analysis, including assessing which environmental impacts should be included, identifying respected literature sources, and checking the analysis for consistency with similar technologies based on our broad understanding of the market. In some cases, the analysis is reviewed with an expert in the appropriate field.

At the end of each fiscal year, the General Partner collects business results data from each portfolio company and calculates the associated net environmental benefits using the analysis framework established at the time of investment. ECG collects and reviews this information and works with the General Partner to update and refine the analysis framework.

Definitions

To facilitate discussion of these environmental impacts, we established a set of definitions as follow.

"Environmental performance (or impact)"

The effects a company's operations and activities have on the natural environment in terms of resource consumption, emissions, effluent, waste, biodiversity, and other aspects of ecosystem quality.

"Direct environmental impact"

The effects on the natural environment that directly result from a company's operations or product manufacturing, usage and disposal.

"Indirect environmental impact"

The effects on the natural environment as a secondary result of the company's technology and activities, such as improvement in the environmental performance of its suppliers or customers.

"Environmental performance indicator"

A measure of environmental performance used to monitor that performance over time. Example indicators might be pounds of materials recycled, gallons of water saved, tons of emissions avoided, etc. *per unit* sold, produced, or installed.

"Sustainability"

Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

"Base case scenario"

The assumptions about the environmental impacts that would have happened in the absence of the portfolio company's existence. Often the industry standard will serve as the base case scenario.

"Net environmental benefits"

Improvements in the absolute sustainability or quality of the natural environment as a result of a company's environmental performance. This is obtained by considering both positive and negative changes to environmental systems that result from a company's products, by-products and technologies, above and beyond the base case scenario.

Appendix I: List of Acronyms

ANL	Argonne National Laboratory
BACT	Best Available Control Technology
BRAC	Base Realignment and Closure
CAA	Clean Air Act
CalEPA	California Environmental Protection Agency
CalPERS	California Public Employees' Retirement System
Ceres	Coalition for Environmentally Responsible Economies
CPUC	California Public Utilities Commission
CRADAs	Cooperative Research and Development Agreements
DEP	Department of Environmental Protection
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
E2	Environmental Entrepreneurs
ECG	Environmental Capital Group
EERE	Energy Efficiency and Renewable Energy
EFAB	Environmental Financial Advisory Board
EIR	Entrepreneur-in-Residence
EISA	Energy Independence and Security Act of 2007
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 2005
EPRS	Environmental Performance Reporting System
ETV	Environmental Technology Verification
FSU	Fresno State University
IETO	Interagency Environmental Technologies Office
INL	Idaho National Laboratory
IPR	Intellectual Property Rights
ITA	International Trade Administration
IVP	Innovation Valley Partners
LEEDs	Leadership in Energy and Environmental Designs
LLNL	Lawrence Livermore National Laboratory
MIT	Massachusetts Institute of Technology
NACEPT	National Advisory Council for Environmental Policy and Technology
NASBIC	National Association of Small Business Investment Companies
NASVF	National Association of Seed and Venture Funds
NRDC	Natural Resources Defense Council
NREL	National Renewable Energy Laboratory
NRMRL	National Risk Management Research Laboratory
OETD	Office of Energy and Technology Deployment
ORNL	Oak Ridge National Laboratory
PNNL	Pacific Northwest National Laboratory
RFS	Renewable Fuel Standard
ROI	Return on investment
RTA	Regional Technology Advocate
SACERS	Sacramento County Employees' Retirement System
SBA	U.S. Small Business Administration
SBICs	Small Business Investment Companies
SBIR	Small Business Innovation Research
SEMATECH	SEmiconductor MAnufacturing TECHnology
SESARM	Southeastern States Air Resource Managers, Inc.
SETO	Senior Environmental Technology Officer
TRI	Toxics Release Inventory
USDA	U.S. Department of Agriculture

Appendix J: References

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