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National Renewable Energy Laboratory

Innovation for Our Energy Future

Enhancing Commercial Outcomes from R&D

A Framework for a Public–Private Partnership to Increase the Yield of Federally Funded R&D Investments and Promote Economic Development

Technical Report
NREL/TP-110-40463
May 2007

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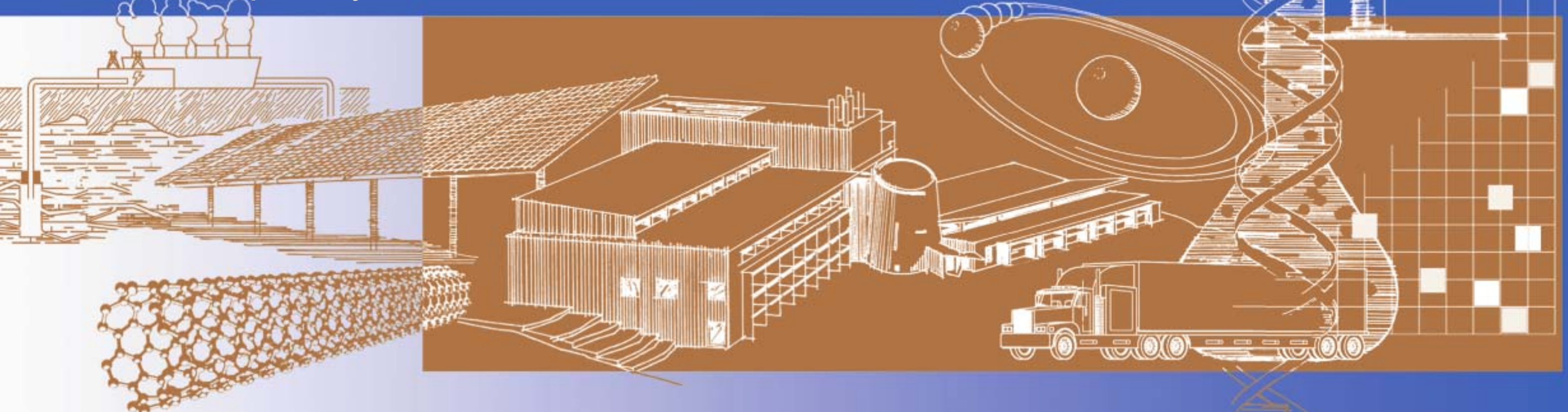

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Prepared under Task No. 1100.1000

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Operated for the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
by Midwest Research Institute • Battelle

Contract No. DE-AC36-99-GO10337

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Preface

This paper investigates an endemic problem facing technology transfer organizations (TTOs) such as those within the U.S. Department of Energy (DOE) and its national laboratories, as well as those within universities and state organizations: The level of technology maturation, product conceptualization, market validation, and human capital required to raise private sector financing and drive commercialization is often too high for technical founders to reach without an industry veteran as a partner.

Although our focus in this paper is on clean energy technologies, the same problems exist for a wide range of other technologies. Moreover, these problems are also often apparent and vexing for many of the private sector R&D partners of these laboratory and university organizations.

Most solutions focus on further R&D without directly engaging private sector financiers and markets, or more recently, on "beefing up" current technology transfer efforts to help technology founders and innovators make their enterprises resemble, and therefore connect with venture capital organizations. We believe however that the best answer may be a paradigm shift in how we think about closing the gap between ideas and commercially feasible opportunities. We present a solution framework for a public-private partnership, which we believe can ultimately be quite robust in addressing the problem while being easily adaptable to the specific needs of various financiers and market forces. This belief is based not only on our own assessment of the situation but on many discussions with venture capitalists and other financiers.

Unlike other public-private partnerships, we have focused on early and seed ventures, which correspond more closely to both the technologies coming out of the labs and the clean energy venture community's need for more robust early-stage company development. Thus, the proposed framework helps to reduce risk for the private sector investor while both enhancing commercial outcomes and increasing the yield of federally funded R&D investments.

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List of Acronyms

ANT	Albany NanoTech
ATDC	Advanced Technology Development Center
ATP	Advanced Technology Program
BOD	Board of Directors
CAB	Capitalization Advisory Board
CalCEF	California Clean Energy Fund
CE	clean energy
CEA	Clean Energy Alliance
CEC	California Energy Commission
CIA	Central Intelligence Agency
Collaboratory	a cooperative effort between NREL, CU, CSM, and CSU
CRADA	cooperative research and development agreement
CSM	Colorado School of Mines
CSU	Colorado State University
CU	University of Colorado at Boulder
DARPA	Defense Advanced Research Projects Agency
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DU	Denver University
IRR	internal rate of return
M&A	mergers and acquisitions
MTC	Massachusetts Technology Collaborative
NASA	National Aeronautics and Space Administration
NDA	non-disclosure agreement
NREL	National Renewable Energy Laboratory
PG&E	Pacific Gas & Electric
SBIC	Small Business Investment Corporation
SBIR	small business innovation research program
SSBIC	specialized small business investment corporations
STTR	Small Business Technology Transfer Program
TSAB	Technology and Sponsor Advisory Board
TT	technology transfer
TTO	Technology Transfer Office
T&PMV	technology & product maturation and market validation
USDA	U.S. Department of Agriculture
VC	venture capitalist

Executive Summary

Purpose. The purpose of this paper is to explore a new model for public sector (i.e., federal and state) investors to further enhance the productivity of their clean energy (CE) research and development (R&D) investments by accelerating the commercialization of these technologies. In addition to moving valuable technologies into products, a robust commercialization program can enhance economic and community development by establishing a clean energy infrastructure in the CO front range region.

Thus, the intended audience is primarily forward-thinking public sector financiers [e.g., U.S. Department of Energy (DOE) and states, in particular CO] who sponsor R&D in the national labs and universities.

Background. CE technologies are increasingly becoming of interest for a rapidly growing number of applications. Within the public sector, energy investors (e.g., federal and state) are attracted to the potential opportunity to spur economic development and job creation, provide improved energy security, and help alleviate environmental concerns.

At the same time, the private sector is demonstrating increased demand for novel CE solutions. According to the research firm New Energy Finance, total investments in clean energy technologies topped $70.9B in 2006, with $7B coming from private equity and venture capital investments. This private sector interest is excellent news for public sector groups hoping to see their R&D efforts turned into commercially-available products.

In addition, concern about the environmental impacts of conventional energy sources, coupled with a growing outcry for "energy security" has hastened the alignment of interests among the public sector, research laboratories, and entrepreneurs with regards to CE. Further, public support has driven favorable state and federal legislation promoting CE and entrepreneurs sensing new opportunities have begun to take notice. On the other hand, R&D laboratories and their public sector sponsors are now being challenged to improve their technology transfer processes and commercialization rates to take advantage of the associated opportunities.

The Challenge. A challenge remains in how to transition technologies from labs to fundable enterprises. Currently, there is good support for R&D, and there is plenty of private sector money (e.g., venture capital) available. Ironically, however, there is a relative dearth (and gap where technologies can be stranded) of resources available to attract private sector financing for transitioning technologies out of the lab. Solving this problem will enable public sector investors to enhance the productivity of their CE R&D investments and generate an increased number of lower-risk/higher-quality opportunities for the private sector investment pipeline.

Private sector financiers invest in market-focused businesses first and foremost, not in technology per se, and they have a number of risk-reducing early prerequisites that are strong indicators of potential market success. For venture capitalists (VCs), the key ingredients for success include an exemplary management team, robust markets, clearly demonstrated superior technology, market-driven products, and finally, good liquidity and returns for the investment. In today's CE environment, the biggest needs are for technology and product maturation as well as market validation (T&PMV). If these key risks remain unaddressed properly private sector investors (even sophisticated angels) will be reticent to fund the commercialization of these technologies.

One common theme that is addressed in a number of different ways is the need for entrepreneurial businesses (and their R&D sponsors), to tailor their companies from inception toward the type of capital investment they anticipate needing, whether it is venture, angel, strategic industry, project, or any other type or combination within the financing food chain. To whit, using an integrated approach that pays particular attention to the anticipated full spectrum of requirements from investors for the venture, even in the early-seed and seed stages, is particularly important. Engaging the anticipated private sector partners early on[1] for these entrepreneurial ventures, as well as obtaining preferable financing and market trajectories, will help reduce risks in many important ways, including preventing poorly thought out early financing rounds from adversely affecting the ability to obtain necessary financing in later stages.

What Is Being Done Now to Bridge the Gap. Resources are available from a number of valuable state and federal programs, which are described in the report. These programs address some of the key stumbling blocks in this funding gap area. However, state and federal programs are often only sporadically available, and the amounts of funding available for investments are small, especially when the wide range of technologies they address are considered.

Additionally, research laboratories and universities have Technology Transfer Offices (TTOs), but these offices are not adequately staffed with the expertise to start companies. It is also the case that their incentives are not aligned with the practice of starting a company; more often, the objective of such an entity is focused on generating intellectual property for licensing rather than commercializing the technology through the creation of a new entity.

The Public-Private Partnership Model. While we have not seen a public-private partnership model that specifically addresses the early stage funding gap, we can look at other successful models that have been set up to promote innovation at other parts of the commercialization chain. What none of these groups has been able to do is show a robust track record of spinning out successful technologies from government or academic labs.

Our early strong success with quality business incubators and the National Renewable Energy Laboratory (NREL) Industry Growth Forums[2] indicates that given the right environment, the risk to investors can be reduced substantially, which enables more CE technology ventures to reach their market potential or at least assures an adequate opportunity.

Our challenge is basically to create an earlier-stage public-private model—To draw from the existing public-private VC model, but also to pull from the best practices of firms and investors who focus on spinning technologies out of national labs.

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[1] See Stevens and Burley (2003), and Murphy and Edwards (2003).
[2] See Appendices C, and D.

We propose an approach that is strongly driven by private sector investor requirements and insights (e.g., their often excellent innate sense of markets). By building on and leveraging the expertise of the private sector early in the commercialization process, technologies with high commercial potential—which might be stranded when leaving the lab due to a lack of funding opportunities—can be identified and aligned more appropriately with the full range of needs for the anticipated investors.

A Novel Public-Private Partnership, to Address T&PMV. To best meet the needs for T&PMV, as described above, we propose a novel, public-private partnership that builds on best practices already established in prior government, non-profit, and private sector investment processes. However, we propose a model that is not unique by is designed to specifically meet the needs of the CE sector: Getting good ideas out of labs and universities, and getting them to the stage where they can be commercialized.

The ESIC Model. In particular, we propose a model where a not-for-profit investment corporation is formed and funded by government and other sources through a variety of mechanisms such as grants and the EPACT's[3] "Other Funding Authority," as well as state allocations such as the recent prototyping legislation in CO.[4] The investment corporation will be focused on forming and nurturing new for-profit companies based on promising innovative technology platforms coming out of the labs and universities. The early seed investment corporation for clean energy, called ESIC, would support T&PMV in newly formed for-profit companies which are being led and directed by highly qualified entrepreneurs-in-residence (EIRs).

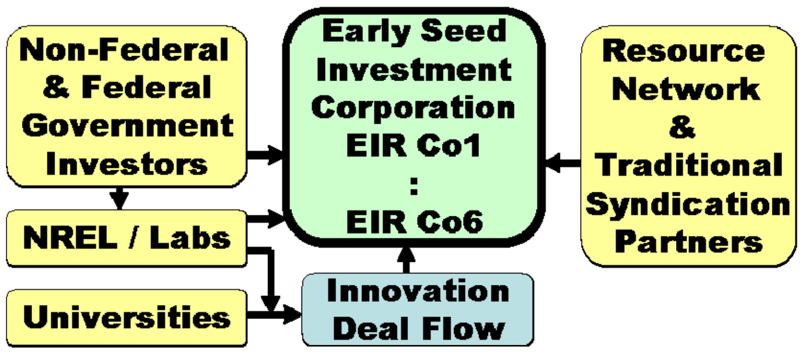


Figure 1. A novel public-private partnership for early-seed and seed ventures focused on technology and product maturation, and market validation.

The ESIC will essentially be a portfolio of start-ups, each of which is developed, led, and matured by a separate individual, largely autonomous, EIR. Any profits that would normally accrue to ESIC through cashing out equity positions by the EIR companies, or EIR-Cos (at their later stages), will be reinvested in new EIR-Cos with the goal of ultimately making ESIC self sustaining. Oversight and guidance will be provided by a board of directors and an eclectic capitalization advisory board, along with a technology and sponsor advisory board.

ESIC, as explained more fully in the body of this report, provides a way to engage federal, non-federal, and laboratory investors, as well as a host of private sector partners and investors (via a robust resource network) in the commercialization of laboratory and university technology innovations. It can also build on and leverage laboratory and university expertise and facilities.

[3] Title X of the Energy Policy Act of 2005 (EPACT), Section 1007.
[4] Reference Colorado HB 1322, 2006

Concluding Thoughts. The model discussed above is a public-private partnership that addresses an as yet unmet need for technology and product maturation, as well as market validation for CE technologies coming out of the labs and universities. The model builds on the success of the government-sponsored VC model, which has proven that public-private partnerships can provide an incentive for small technology companies to develop government-specific technologies, and moves that public-private partnership idea to an earlier stage in the development pipeline.

We specifically mirror the best practices of firms that have spun technologies out of government and university labs, choosing an EIR approach that focuses on commercial markets and is well-matched to these nascent technologies. This approach uses a robust resource network to bring a wide spectrum of expertise to bear on the unique problems with these very early investments. Moreover, the suggested approach puts investment decisions unambiguously in the hands of private sector investors and entrepreneurs, who are driven by marketplace success and will therefore have proper incentives to develop commercial opportunities, which in turn, benefits the public. Additionally, this approach builds additional CE technology expertise within the financial community which the public sector can more easily access.

The recommended EIR/ESIC approach provides a unique way for the national labs and universities to improve their technology transfer and most importantly to enhance regional economic development by creating CE-based jobs and businesses, as well as encourage a CE economic cluster in the CO Front Range.

Finally, the ESIC model represents a new paradigm in engaging, leveraging, and integrating private sector investor insights and feedback, especially those related to market readiness and relevance of the various technologies that are being created by the labs and universities. It has the potential to be a powerful commercialization tool for use by a much broader range of public sector technology programs as well as for individual technology innovations.

Introduction

CE technologies are increasingly becoming more market competitive in a rapidly growing number of applications; and their costs are still coming down, while conventional sources are increasing in cost. In addition, the high cost volatility for conventional energy sources enhances the value of alternatives. As a result, CE technology-based companies, which have a strong market focus, are becoming increasingly attractive to investors. Further, albeit starting from a small base, CE is one of the fastest growing areas in the investment community. Not only have the number of investments and dollar volume increased rapidly, but also recent investment forums have highlighted the fact that very strong and experienced management teams are being recruited and formed around CE technology-based ventures.

Still, while technology innovation remains one of the key catalysts behind sustainable energy market growth, public sector financiers (both at the state and federal levels) know that only a very small fraction of the technologies coming out of the lab[5] is being embedded in products that reach the commercial marketplace. Also, the number of deals financed in the private sector is still relatively quite small. Although we discuss this issue more fully in Appendix A, an introductory review of available government and private data indicates that as many as 3,000 ideas, leading to about 100 patents can be needed to attain one commercial success.

While there will undoubtedly always be a relatively small number of commercial successes compared to a much larger number of new innovations, there is clearly is room for improvement, and public sector investors would like to see the yield on these technology investments increased. Moreover, to sustain the growing investment interest in CE, public sector investors know that a sufficient pipeline of good deals must be made available. Here "good" means that the risk-adjusted returns on such investments are at least comparable to other investment opportunities that they may have. Our sense is that both of these issues need attention and that they can be adequately addressed while reducing risk to private sector investors, specifically by providing significant value through technology and product maturation, along with market validation.

As a prelude to this discussion, one final contextual issue should be mentioned. There are major differences in perspectives and objectives between public and private sector investors.[6] These differences impact significantly where and how these investors allocate the bulk of their resources, and these differences greatly influence how the two sectors can work together. For instance, public sector investors have a strong technology focus[7] while private sector investors have a strong business and market focus—they invest in businesses with market-driven products, not technology. Moreover, even within the spectrum of private sector investors, differences must

[5] Here "lab" refers to organizations like NREL, the California Energy Commission, and to universities, as well as other research labs.
[6] See Appendix B to get a clearer picture of these different perspectives, for example, when looking at public sector investors and in this case VCs.
[7] However, the public sector does keep there eyes on macro-level markets in meeting public good needs.

be considered; e.g., each investor type along the pathway to commercialization will have a different risk tolerance.[8]

We use the term entrepreneurial company (or venture), to mean an early-stage business entity that has a strongly focused intent to embed its technology within a market-focused product and business, and to ultimately attain success in the marketplace. Without the marketplace success, public sector technology investments lie fallow.

Where do these entrepreneurial ventures come from? In some cases, such an entity already exists in its early formative stages and has worked with the labs as a collaborative R&D partner [e.g., with NREL, the California Energy Commission (CEC), or Albany NanoTech (ANT) at the state level]. In other cases, small entrepreneurial companies may be formed around key licenses, which were created and owned by the labs.[9] In our subsequent discussion, we assume that such a market-focused business entity exists or will be formed around the technology coming out of the lab as a first order of business.

[8] For example while VC's accept some technical risk, project financiers will accept none. See Goldman et al. (2005).
[9] Of course direct licensing from the lab or university is possible in some cases with an existing, well-established company for exiting or new product lines.

The Funding Gap

Only a very small fraction of early-stage technologies are embedded in products that reach the commercial marketplace. One of the problems, as depicted in Figure 2,[10] shows that early in the process, public sector funds may be available,[11] and that later in the process private sector investment becomes available if the business continues to evolve effectively. Further, after the business becomes cash-flow positive, project and other forms of debt and equity (e.g. expansion capital) become more available. However, after the technology leaves the lab, but before it can qualify for traditional venture funding, there is typically a "gap" in equity and venture capital funding availability as depicted by the cross-hatched area.

Characterizing Needs within the Gap

Part of the problem is that there are major differences between the perspectives and objectives of public and private sector investors.[12] These differences impact significantly where and how these investors allocate the bulk of their resources. For instance, public sector investors have a strong technology focus[13] while private sector investors have a strong business and market focus. As such, when technologies leave the lab and enter this gap region, the key stumbling blocks to accessing capital are market risks associated with underdeveloped (and often poorly defined) commercial plans. Thus, there's a need for technology and product maturation as well as market validation. More specifically, these needs can be described as follows:

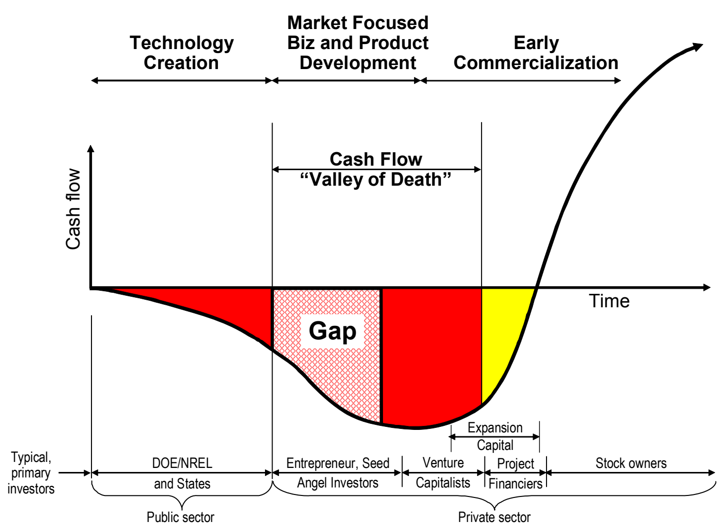


Figure 2. The cash flow valley of death as a function of development stage (time) with typical investors shown for the various stages.

- Technology maturation – the need to have both scale-up and performance verification information on the technology that will make investors and other strategic partners more comfortable with the concept and its ability to perform as it did in the lab.

[10] Figure 2 is for illustrative purposes and depicts the situation that many CE companies face. Details in terms of timing and kinds of investors can vary quite a bit; for example, with different kinds of technologies, or even from deal-to deal.
[11] Product development and marketing efforts are specifically not allowed, particularly in federal R&D efforts.
[12] See Appendix A to get a clearer picture of these different perspectives, for example, when looking at public sector investors and in this case VCs.
[13] However, the public sector does keep their eyes on macro-level markets in meeting public good needs.

- Market validation – the need to understand and demonstrate that there is, or can be, strong markets for the technology, along with a strategy for reaching those markets, may require a number of staged markets including beachhead markets (where technology validation and market credibility are established). These beachhead markets will often look considerably different from the long-term markets, and they are crucial in gaining market experience and acceptance for the technology. Clearly market awareness is needed before market-focused products can be developed. And an understanding of the competition in the marketplace is needed.

- Product maturation – the need to transform the technology into early market-driven, market-ready products including prototypes specific to initial markets and "whole product" solutions. This often requires significant time and money[14] because market-focused products based on technologies emerging from the labs are typically insufficiently developed / demonstrated to attract commercial investment. Full scale-up and manufacturing issues also need to be further addressed. Finally, to meet user needs, a product may require certification (e.g., through the UL [Underwriters Laboratories] process) consistent with industry practices. Strategic partnerships can be crucial here, especially for building and manufacturing prototypes as well as providing verification testing for specific markets.

Concurrently, in this process of developing more mature technologies and early market-focused products, it is important to develop an understanding of, and address the likely interface requirements of the essential, subsequent private sector investors and anticipated strategic partners. This includes the need for both the entrepreneur and the public sector sponsor to understand, for alignment and strategic positioning purposes, the needs of all anticipated investors. This is important whether the business plans to take the technology-based product to the market itself, or by forming an alliance and eventual merger or acquisition (acquisitions are the most common exit strategies for investors in small technology businesses, whether venture backed or not).[15,16]

Another important reason for the new venture to develop realistic financing expectations and alignment with future investor needs is to help prevent the early financing rounds from adversely affecting the ability to obtain later financing rounds. As a part of this interactive process, entrepreneurs (and their early-stage sponsors) should recognize the rigorous tests that later investors will put them through before writing checks. And each investor type along the commercialization path will have different requirements and lower tolerance for potential risks.

[14] See Moore 1995.
[15] Considering both mergers and acquisitions (M&A) together, an M&A is about 5-10 times more likely to occur than an initial public offering.
[16] The British use the term agency risks, where incomplete alignment between investor and investee interests exists. At least one writer cites this as a major risk for high technology investments. See Reid and Smith (2001).

Investor Perception of Risks in the Valley of Death, Including the Gap

It is interesting to see how investors view the risks in the valley, while noting that they must be compensated more for taking on more risk. Thus for earlier-stage businesses, they will require a commensurately higher internal rate of return (IRR). In this regard, Table 1 below provides the level of IRR sought by venture capital investors as a function of the business development stage. Referring back to Figure 2, the gap we are discussing corresponds to the seed and very early-start up stage where the required IRR is 50%-100%.[17] Many investors believe that they have not yet seen the required returns (there are some exceptions of course) to justify these early stage investments.

Table 1. Typical Rates of Return Sought by Venture Capital Investors

Table I – Typical Rates of Return Sought by Venture Capital Investors (Timmons. 1999, p465)		
Stage	**Annual IRR,%**	**Typical Expected Holding Period (yrs)**
Seed and Startup	**50-100% or more**	**> 10**
First stage	**40-60**	**5-10**
Second stage	**30-40**	**4-7**
Expansion	**20-30**	**3-5**
Bridge and mezzanine	**20-30**	**1-3**
LBOs	**30-50**	**3-5**
Turnarounds	**50+**	**3-5**

Note that most VCs want to hold their investments for between three and seven years, which would correspond to second stage in this table, and a 30%-40% IRR on their investment.[18] First-stage investors are the so called early-stage VCs. High risk and the need to require very high discount rates are why venture folks typically don't want to invest at the seed stage, and why it is often prohibitively risky for most entrepreneurs as well (they risk losing way too much of their business in a short amount of time). Moreover, it can easily be seen that a small amount of patient investment in technology and product maturation can potentially have a big impact while helping the company preserve ownership.

Given the stage entrepreneurial ventures are at when their technologies leave the lab, and the fact that the sweet spot for VC investors is the late first stage and second stage, it is imperative that the technical and initial product risk be reduced as much as possible.[19] Finally, as shown in Table 1, it is important for entrepreneurs and their public sector sponsors to remember that the returns cited are what investors seek for each element in their portfolio. The portfolio as a whole very rarely reaches these levels (Zider 1999).

We can gain more perspective on the very early stages (including early-seed which is not addressed by Timmons [1999] or other VC publications), by combining our work with that of Jolly (1997), and Murphy et al. (2002). The early-stage key processes, requirements, and players are provided in Table 2 below, where the requirements column lists milestones typically required for each financing stage. Unlike Timmons (1999), the seed and start-up stages are represented in separate rows, and there is an additional row corresponding to the early-seed stage, called Technology and Concept Generation. The Technology and Concept Generation stage

[17] These high discount rates account for risks that cannot be addressed through portfolio diversification and uncertainties such as the risk that the company will go out of business. See Hellman (2001).
[18] One often hears that VCs like to get 10 times their money in at most seven years—this corresponds to about a 39% IRR.
[19] Table 1 also shows why it is important to align with future investors.

corresponds to where most technologies are in their development stage as they come out of the labs.

The last column, *key processes*, refers to the multifunctional and interlinked processes that are needed for each stage. Note that each stage of private-sector financing, including the early-seed stage, includes a distinct *market component*—though the requirements of the market component will vary as the business evolves. For example, in the early-seed stage, the entrepreneur must define the market need and attempt to roughly quantify it. In the seed stage, markets must be carefully quantified, competition characterized, and initial customers identified with letters of intent to purchase if possible. In the start-up phase, the customer base must be growing rapidly to obtain the next round of financing.

Because many lab entrepreneurs develop their enterprises in an uneven fashion, focusing almost exclusively on technology development and engineering, they often assume they are ready for seed or start-up financing when, in reality, they have not satisfied basic market and business planning milestones required by most seed financiers. For example, they may have secured key patents, but they often lack initial commercial feasibility and prototype demonstration. Thus these businesses should be considered early-seed stage. Moreover, it can be seen from Table 2 that the early-seed and seed stages require technology and product maturation as well as market validation.

Table 2. Qualifying Requirements for the Next Round of Financing and Key Processes Involved for Specific Financing Rounds (Adapted from Jolly (1997) & Murphy (2002))

	Financing Round	Who Typically Plays	Typical Qualifying Requirements for Next Round	Key Processes
Technology & Product Creation & Maturation	Technology and Concept Generation	Entrepreneur, Friends/Family & Public Sector	▪ Exciting technology concept, linked to a market need ▪ Applications identified	▪ Research ▪ Development ▪ **Marketing**
	Early-Seed: Technology Development	Personal / Public Support (e.g. DOE/ATP /SBIR/States) Believer Capital	▪ Key patents applied for/secured ▪ Technical feasibility and initial commercial feasibility with prototype demonstrated ▪ A plan for taking the business forward is available ▪ Substantial market need quantified and competition identified	▪ Development ▪ Engineering ▪ **Marketing**
Market Focused Business Maturation	**Seed:** Prove a concept qualifies for start-up capital	Individual Angels Angel Groups Early-stage Venture Capitalists Believer Capital	▪ Business/commercialization plan available; ▪ Specific markets, including competition, well characterized; and initial customers identified ▪ Attractive market-ready products /or processes available. ▪ Management team identified	▪ Development ▪ Engineering ▪ Manufacturing ▪ **Marketing**
	Start-up: Complete product development and initial marketing	Select Individual Angels Angel Groups Early-stage Venture Capitalists	▪ Launch of commercial product and/or process ▪ Strong management team in place ▪ Rapidly expanding customer base	▪ Manufacturing ▪ **Marketing**
	First: Initiate full-scale manufacturing and sales	Venture Capitalists	▪ Large customer base, and still growing by new constituents ▪ New products and new processes	▪ Research ▪ Development ▪ Engineering ▪ Manufacturing ▪ **Marketing**

Should More Companies Really Get Through This Gap Region?

Investors (e.g., many VCs) sometimes say the best ideas are the ones that get through the valley of death, and subsequently, they don't concern themselves with the problem. While there is some truth in this assumption, it also is likely true that a lot of the best ones don't get through the valley due to a host of reasons that tip the balance towards selection of less innovative, and in many cases less capable (in terms of ultimate cost and performance) technologies. They are often products and technologies that are able to enter the marketplace more quickly, and which can more effectively meet the other major requirements of most VCs.[20] While VC insights are always valuable regarding business fundamentals such as strategy and market viability, it is also important to note that just because a VC may not have an interest in a business, this does not automatically mean that the business and/or its products are not sound. It could also mean simply that the business does not meet the model used by the VC community, at least in its current state. Several examples of this kind of disconnect are described below.

To be fair, it is true that the ideas that best fit the required investment criteria (based largely on risk) at a given moment in time are most likely to be funded, but ultimately there may be even better technologies left on the table. Moreover, our experience confirms that with appropriate mentoring and alignment with the appropriate investor types, many more good ideas can emerge from the gap; but it generally won't happen without additional work and resources. Most importantly it won't happen without the stewardship of a good management team that has a clear market focus. For instance, a great many investors readily admit that they will often take an "A" management team (the first priority with most investors) with a "B" technology, but never the opposite—of course they always look for "As" in both categories.

Given the disconnect in focus, needs, and priorities between the federal/state sector and private sector investors like VCs,[21] it is not surprising that a smooth transition between public investors (and the entrepreneurial ventures they support) and private investors is difficult to achieve. In fact, Reid and Smith (2001) note that the lack of alignment between investor and investees is a major source of risk with high-technology investments. We think joint participation in product and technology maturation can greatly enhance and align the interfaces between public and private sector investors and entrepreneurial ventures.[22] Finally, we frequently hear VCs state that if a technology was developed a little further, they would have significantly heightened interest—the technology and market potential seem promising, but the risk associated with the current state of technology development is too high.

In some cases, technologies coming out of the labs may not align with market needs. For instance, they may have been created for an application or market that is not the best for entering the marketplace early on; other applications and markets may be much more promising for beachhead markets. Also, in some cases, the public sector interest in a technology that has been

[20] Clearly, it is to be expected that a good portion of the public sector portfolio of R&D innovations is not going to be commercially viable. Taking this initial high risk has been the traditional role of government participation in R&D.

[21] See Appendix A for more information on the different perspectives.

[22] Such alignment of the interfaces might be looked at, in the parlance of system integration, as investment system integration where engineering the interfaces between key system elements is always a key concern.

created may be quite good but may not best meet, on a priority basis, the objectives for the public good as originally defined by the entities funding the technology development programs.

Public sector investors at both the state and federal level have always focused on reducing early-stage technology risks, and by many measures they have done a very good job with this. However, private sector investors want other types of risk to be reduced even further for their involvement and investment. We believe that through sharing risk in this gap region, more technologies can ultimately be commercialized, thus creating significant value for both the public and private sector investors.

Understanding and Matching Investor Needs Is Crucial

As noted above, the risks associated with many technologies/companies coming out of the labs are just too great to attract private sector capital. It is interesting to take a closer look at the characteristics of these companies and see how well they match up with investor requirements. For a point of reference and comparison, we will again use the VC perspective; see the sidebar for a quick summary. The important message is that entrepreneurs should tailor their companies from inception with the kind of capital investment they likely anticipate needing, whether it be any combination of venture, angel, strategic industry, project, or other kind of financing.

It is also important that public sector investors set realistic expectations for themselves based on their own public-good missions, when sponsoring and guiding these companies in developing the technologies. To set realistic expectations, public sector investors should engage private sector investors in a dialogue as soon as feasible during the commercialization process, even while the technology is in the early R&D stage. Private sector investors—

What Venture Capitalists Look For (From Murphy & Edwards, 2003)

There are several key elements that venture investors look for in the ideal investment. More specifically (in order of importance) these are:

- **Management. Personal qualities should include integrity and adherence to a set of concrete, constructive principles. Management should be highly motivated and focused. "Renaissance" individuals who can deploy many skills while remaining creative and flexible are preferred. Successful entrepreneurial experience of the CEO is a major advantage.**
- **Market. To attract venture capital, the market and growth opportunities should be huge. The larger the investment the larger the market should be. Venture investors play in a high-risk, high-reward arena, and they generally will only look at an investment opportunity offering potential returns of at least 10 times their initial investment within a three- to five-year period. This target may be relaxed somewhat for later-stage enterprises. Ideally the company is selling product in the marketplace. For early stage investors, the company should be in the marketplace within two years of the initial investment.**
- **Technology. The company should have a technology that is *significantly* better than that of all known competitors; will provide the company with a competitive advantage for at least as long as it will take the company to hit its high-growth period; is proprietary to the company; and that is legally protected, preferably with worldwide patents.**
- **Liquidity. Venture capitalists and other private financiers must be able to get their money out of a company either in the form of cash or marketable securities. This generally occurs when the company goes public or is acquired. If a company has no likelihood of going public or being acquired for cash or marketable securities, investors will generally not invest in it.**
- **Company structure. Ideally the investee company should be a corporation rather than a partnership or LLC. There should be one class of stock–common stock–immediately prior to the venture investment. Except in rare circumstances the company should own all the core technology outright rather than being a licensee, even if it is an exclusive licensee.**
- **The company should not be too dependent on the success of another entity for their success; investors prefer stand alone opportunities.**

including strategic corporate, angel, venture, and others—can provide a wide range of insights (e.g., market identification) in this early commercialization stage, which can be extremely important as new ventures move forward.

While the very early nature of these businesses and the need for technology and product maturation as well as market validation are most apparent for technologies coming out of the lab, some of the businesses in which the public sector (e.g., DOE and states) invests may never fit the venture capital model even though the entrepreneurial firms may have businesses based on high-quality technologies.

The sidebar on page 10 shows why companies may not fit the VC model. For instance VCs generally don't like to invest in licensing deals or service businesses, since the returns are lower than what they usually target and the exits are not well defined. Likewise, commodity businesses often don't provide sufficient returns to justify the risks that will have to be taken. Additional examples include:

- Many demand-side technologies are not attractive to VCs since they often represent a small piece of a bigger system (e.g., a controller in a much larger and more costly air-conditioning system). VCs prefer stand-alone systems and businesses where they don't have to accept risks with system elements/components they don't control. The risk asymmetries are readily apparent here.[23]
- Some technologies that are most likely to be adopted by utilities, such as energy efficiency, often are also difficult to finance by private sector investors such as VCs. Utility business and investment structures often do not favor small capital outlays or energy efficiency investments, which will reduce the amount of the energy (and revenue from) that they sell. Moreover, utilities are typically very conservative, and in a lot of ways this is appropriate, since they must protect a large infrastructure. The risks, though small, are unacceptable, and the staff is not paid to take risks. Such businesses are often not attractive to many types of investors, since the markets are uncertain. Even if one utility adopts them, other utilities may not, and so the markets can be quite constrained. Yet smart public-good policy, which protects the adopters and the public from downside impacts, is appropriate if the technologies show strong long-term potential. The good news on this front is that some forward-looking utilities are now addressing this issue.
- Many companies based on technologies coming out of the lab often require strategic partnerships that include licensing, marketing, manufacturing, and/or distribution. These partnerships, if not structured correctly, can make a deal unattractive to VCs, resulting in returns that are quite a bit lower than those typically targeted. Further, exits are often difficult and not well defined—again leading to the perception of unacceptably high risk by a VC.
- Additionally, the public sector invests in many small companies that simply don't want to carry out all that is required to build a stand-alone business with all the other key elements (e.g., manufacturing). In such cases, an early buyout is frequently sought.
- Also, some entrepreneurial ventures, in their desperation to obtain early financing, develop and/or accept complex and poorly thought out ownership and other relationships with angel or other independent financial investors (e.g., friends and family), which make it quite

[23] Similar asymmetrical risk considerations can occur with strategic industrial partners as well when they consider these technologies in their existing products.

difficult for VCs to unwind the deal so that it is attractive to them. For instance, early on, non-dilution clauses can turn away future investors.

- Finally, small publicly held companies, which may want to raise money from VCs, often find it difficult due to the complexity of ownership as well as regulatory compliance issues (e.g., Sarbanes–Oxley rules).

Upward Trends in Later Stage Clean Energy Investments

While there has been a good deal of recent interest in CE by private sector investors, their investments are not addressing the early stage funding gap described in the previous sections and this has specific implications for the CE sector.

Over the past few years, there has been a dramatic increase in the amount of capital that has flowed into energy-focused venture funds. EnerTech Capital, for example, claims that 80% of its $290M under management ($232M) is in clean energy; moreover, DFJ Element, a CE-specific fund, had raised $120M by the end of 2005.[24] However, this capital has not necessarily been leveraged into startup companies. Data from Nth Power, shows (see Figure 3) that $917M was invested in CE in 2005, representing 4.2% of total VC investments last year (preliminary information for 2006 indicates that these numbers will be close to $2B and 9%, respectively). Unfortunately, at just under $11M per investment, this equates to roughly 85 investment opportunities in 2005. So while this increased interest has been evident, the number of attractive opportunities is still rather small. Taken a step further, this has led to increased investment competition.

The fundamental problem driving this scenario is that, unlike other mature sectors, the CE industry is still in its nascent stages. The lack of an existing or legacy industry means that investors are flying blind, without the benefit of existing companies they typically rely on for new ideas and entrepreneurs.

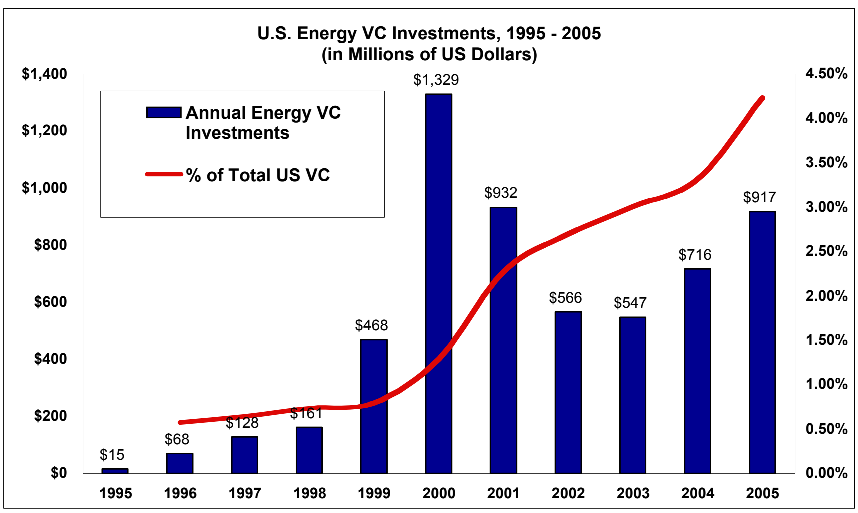


Figure 3. US Energy VC Investments, 1995 – 2005 in Millions of US Dollars. Source: Nth Power

Conversely, this dearth of companies from which to mine ideas and talent creates an opportunity for the lab and university systems. Given that the next great ideas cannot – and will not – come from within a large company, they will have to come from research institutions. History demonstrates, however, that research institutions do not typically possess the expertise necessary to wrap marketable business models around these great ideas.

[24] The End of Oil? Venture Capital Firms Raise the Profile of Alternative Energy.

As such, the CE industry is uniquely primed for a gap-filling solution that is designed to identify and extract technologies from labs and pair them with the entrepreneurial expertise to wrap an intelligent business model around the technologies.

What is Being Done Now by the States and the Federal Government

While acknowledging the challenges above, there are a number of efforts that are beginning (albeit in a piecemeal way) to address the above problems, specifically to help reduce the real and perceived risk to private sector investors, especially early on. We give a brief overview of some of the key state and federal efforts in Appendix E. Most of these efforts help to reduce technical and related early product risk; e.g. some are specifically focused on technology and product maturation as well as market validation. When taken as a whole, the state and federal efforts indicate recognition of the problem and the need to engage both public and private sector participants to reduce risk.

For example, the total combined resources from the states for commercialization are now greater than the federal government can currently deploy, and they are not quite as constrained as their federal counterparts in commercialization efforts. Most state programs are ,however, uncoordinated and are typically small in size and their availability is geographically limited. Yet large states such as California, Connecticut, New York, and Texas have wide ranging efforts that help in the commercialization process in a number of ways.

The federal government also has a number of very valuable resources focused on technology maturation, including the Advanced Technology Program (ATP) and the Small Business Innovative Research (SBIR) Program. ATP and SBIR, though quite significant, cannot adequately address the technology spectrum that they cover. Further, federal programs such as ATP and SBIR don't directly engage the private sector financiers in the ways that we envision are necessary to adequately abet commercial success and they not do a sufficient job of fostering the understanding of, and addressing the interfaces with anticipated investors.

That said, the federal government has demonstrated that it can be quite innovative when priorities are aligned [e.g., In-Q-Tel Venture Fund and similar funds in several groups within the armed forces (DoD) and NASA]; though these tend to have a venture capital focus and have an emphasis on government markets. Another problem with many federal programs is that they can be too focused on solving the problems of one government agency, often limiting market applicability and perspectives.

Filling the Commercialization Pipeline & Creating Value

While we discussed several effective examples of public-private partnerships in an earlier section, none of these models are appropriate templates for matching the unique gap-filling needs of the CE industry. Given the need for T&PMV, we propose an innovative model that combines the best practices already established in successful public-private partnerships with the private industry's best practices for spinning early-stage technologies out of university and national labs.

A Framework for a Novel Public-Private Partnership

We propose a model where a not-for-profit early seed investment corporation (ESIC) is formed and funded by government and other sources through a variety of mechanisms such as grants and the EPACT's "Other Funding Authority," [25] as well as state allocations such as the recent prototyping legislation in CO[26] (see Figure 4). The investment corporation will be focused on forming and nurturing new for-profit companies based on promising innovative technology platforms coming out of the labs and universities. This will thereby accelerate the commercialization of CE technologies, enhance technology transfer from the labs and universities, and promote local economic development and jobs, as well as provide a key element in the formation of a CE economic cluster in the CO front range.

Framework Overview

The investment corporation will provide early seed financing to address T&PMV in newly formed companies led and directed by highly qualified entrepreneurs-in-residence (EIRs).

The ESIC will essentially be a portfolio of start-ups, each of which is developed, led, and matured by a separate individual, largely autonomous, EIR. Any profits that would normally accrue to ESIC through cashing out equity positions by the EIR companies, or EIR-Cos (at their later stages), will be reinvested in a new EIR-Cos with the goal of ultimately making the ESIC self sustaining. Oversight and guidance will be provided by a board of directors and eclectic capitalization advisory board, along with a technology and sponsor advisory board.

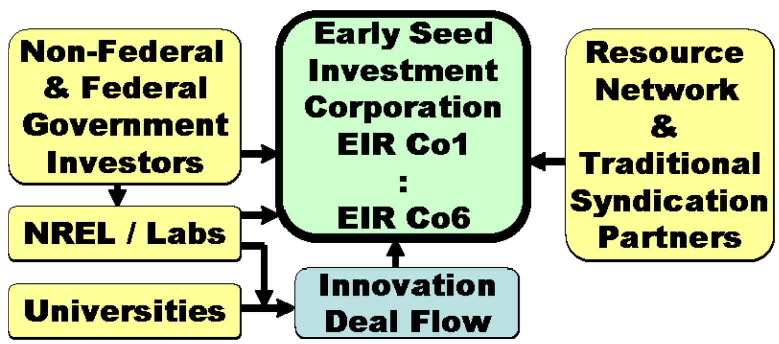


Figure 4. A novel public-private partnership for early-seed and seed ventures focused on technology and product maturation and market validation.

[25] Title X of the Energy Policy Act of 2005 (EPACT), Section 1007. See also Appendix G
[26] Reference Colorado HB 1322, 2006

The EIR Role[27]

Within the ESIC, the EIRs will focus on forming and evolving newly created (or existing emerging technology-based) businesses to the point where they qualify for private sector funding; e.g. knowledgeable angel, early venture, or possible other funding such as strategic business partnering through an acquisition or merger. As part of this process, the EIRs will also position these nascent companies to effectively engage the other important participants in the down-stream portion of the financial food chain.

Candidate EIRs will primarily be successful serial entrepreneurs looking for technologies from the labs and universities to build a business around (and their next big deal that they can lead, manage and profit from), and /or emergent small technology-based businesses that need to grow into market-focused businesses. Principals from existing small technology-based companies generally would not be candidate EIRs unless they have a proven successful track record on the business side of forming early stage start-ups.

EIRs will need access to the labs' technology portfolios, and the corresponding technology champions, with the goal of matching them (based on mutual interest, congruent needed expertise, and other criteria) with key technology platforms coming out of the labs. The EIRs will be responsible for defining successful commercialization and funding paths and creating business plans that will lead to the creation of market-focused products and businesses.

EIRs will present their plans, which must have clearly defined technical, business, and market milestones, for approval by the Capitalization Advisory Board (CAB) and then the Board of Directors (BOD) (discussed below). Once a plan is approved by both CAB and BOD, the EIR-Co will receive funding (anticipated to be no more than $750-1000K) from the ESIC's pool of capital (defined below).

The EIR will then be responsible for implementing the plan and seeking additional syndication and other funds from a range of sources to form and mature the EIR-Co. As part of their compensation, each EIR will receive a founder's equity stake in their respective companies to complement their modest salaries. Thus, the EIRs provide stewardship for resources from the not-for-profit government partners that will be applied to early stage technology and product maturation as well as market validation.

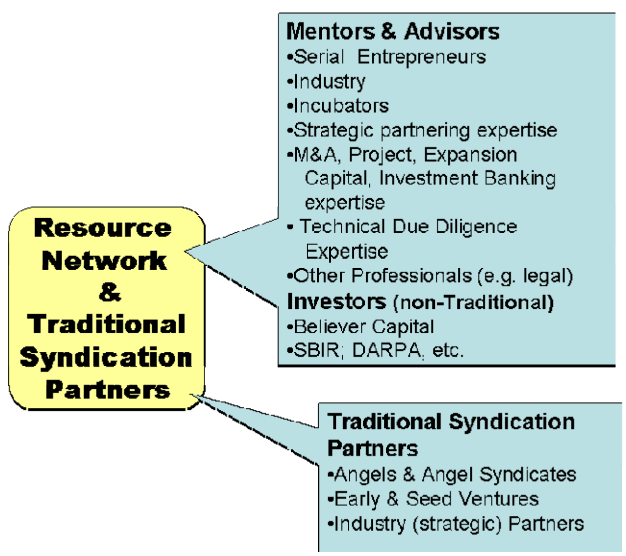


Figure 5. A robust resource network with both traditional and non-traditional financial partners

Resource Network

ESIC will be complemented and supported by, a robust resource support base network including access to angel investors, entrepreneurs, industry

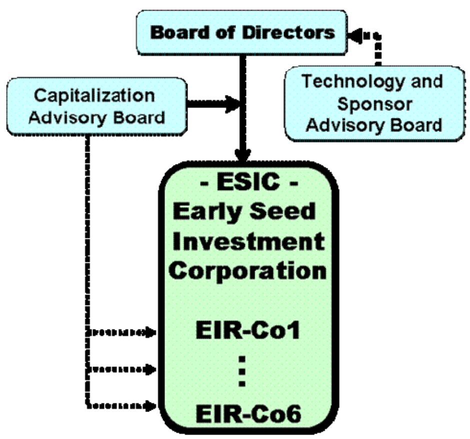
[27] See Appendix H for a short summary of selected current EIR programs and references.

strategic partners, technical, market information, and due diligence expertise to stimulate the development of innovative CE technology based businesses, especially those within ESIC.

The resource network will provide value to the fund and its supporters by providing a more robust resource base of information, potential strategic partners, expertise, and resources to support the fund and develop the economic development cluster. The network will also add value by making available an off-ramp for technologies and products that can appeal to investors other than venture and angel investors (e.g. utilities and industry strategic partners as discussed in the sections above).

Management and Governing Roles

The ESIC and its EIR-Cos will be guided by a small management team (e.g. an anticipated manager and two administrative people), the BOD, and two complimentary advisory boards–a Capitalization Advisory Board (CAB) and a Technology and Sponsor Advisory Board (TSAB).



ESIC Needs	Key Source
Operations	
ESIC Management	DOE, GFO, OEMC, NREL
EIRs	VCs, CCI, Resource Network
EIR Salaries	VCs, Other
Tech Maturation	
Prototype Development	OTA, SBIR, ATP, Other
Collaboratory* - Protoype Support	OTA, STTR, Programs
Technical Expertise	Collaboratory (NREL, CU, CSU, CSM)
Facilities (e.g. PDIL)	Collaboratory
Private Investment	
Equity Inestment	Angels, VC's, & Believer Capital, $s
Other Strategic Partners	Resource Network
Innovations for EIR Co's	
Deal Flow - Tech Innovations / IP	Collaboratory, NST, DU, CCI, NOAA

* Collaboratory = NREL, CU, CSM, CSU

Figure 6. ESIC and its advisory and director boards

The BOD will be made up of angels, VCs, and representatives from the government-sponsoring partners, to provide oversight to ESIC. and will play a major role in forming the other two advisory boards. This group will also play a key role in identifying, developing, and accessing other funding.

The Technology and Sponsor Advisory Board (TSAB), consists of government investor program participants, along with technology experts whose interests are aligned with sponsored research investments. This group will advise the BOD on programs and related technology issues.

The Capitalization Advisory Board (CAB) will be composed of professional investors, with an emphasis on VCs, some of whom may choose to serve on the boards of individual EIR-Cos. The CAB's main purpose will be to help prioritize and select proposed deals coming from the EIRs. In addition, the CAB will also help identify and select candidate EIRs with proven track records. Further, CAB members may potentially support EIR salaries for an equity position in specific

EIR-Cos. Example key ESIC participants and corresponding responsibilities are presented in Appendix I.

Funding

Direct funding for the management and operation of the ESIC, as well as for seed investments in individual EIR-Cos is anticipated to come from a pool of money raised from government sources such as USDOE, USDA, and the state.[28] Though EIR salaries may potentially come from CAB members, the salaries would otherwise most likely be paid from this funding pool.

For each EIR-Co, additional funding will be raised by the EIRs from a range of sources as they nurture and grow their businesses. These potential sources include, but are not limited to: equity investment syndication from VCs, angels (including members of the CAB and resource network); grants from SBIR and DARPA; and Cooperative Research and Development agreements (CRADAs) sponsored, for instance, by the organization that generated the original R&D. In addition, another source of support might also come from the exchange of IP and CRADA support from labs and universities for equity stakes in the form of warrants.

Technology Access/Filling the Pipeline

Deal flow from NREL, affiliate labs, universities, and technology-based businesses will provide deal flow to the ESIC and its EIR-led emerging businesses; key universities include, but are not limited to, the University of Colorado, Colorado School of Mines, and Colorado State University who along with NREL form what is called the COLaboratory. In addition, leads from the various boards and the resource network will be evaluated and pursued as appropriate. [29] Particularly relevant to the front range is the Colorado Clean Tech Initiative, which is actively identifying and mentoring, incubating, and growing existing Colorado businesses.

Synopsis of ESIC Benefits

Summarizing the unique features of ESIC relative to the VC fund models mentioned in the above sections of this report, we note that all have non-profit limited partners, while our proposed approach includes a focus on: 1) early seed and seed investments to best address the T&PMV needs; 2) putting the responsibility for making investments clearly, and unambiguously in the hands of professional, private sector investors and business entrepreneurs (in a market driven, technology pull approach)[30]; 3) using an entrepreneur-in-residence approach; 4) providing returns to the professional investors that are commensurate with private sector opportunities – thus assuring the involvement of quality investment professionals and organizations; and 5) access to a robust resource network that also supports the fund and the development of a wide range of CE and related infrastructure businesses.

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[28] E.g. from DOE's "Other Transaction Authority" a la EPACT 2005, Section 1007. See Appendix G

[29] Particularly relevant to the CO front range is the Colorado Clean Tech Initiative, which is actively identifying and pursuing mentoring, incubating, and growing existing Colorado businesses.

[30] With minimal intervention by the government sector – primarily to prevent unwarranted technology push, and so that public sector program needs do not trump real market needs and opportunities. This will also probably require that the limited partner funds be escrowed to assure that they will be available for a capital call when an investment is required.

A Special Opportunity

A public-private model with a CE focus, such as the one we are proposing, can take advantage of an opportunity that is unique to today's social, political, and economic dynamics. What is special about this opportunity is that there is an alignment of interests among the public sector, research laboratories, and entrepreneurs. Specifically, with increased concern about the environmental impacts of conventional energy sources, coupled with a growing outcry for "energy security," CE technologies are gaining public support. This support has caught the attention of public officials, which has resulted in favorable state and federal legislation promoting CE. Entrepreneurs sensing new opportunities have increasing awareness and interest in this space. Research laboratories have been plagued by the barriers between the development of new technologies and commercialization. And since they have a wealth of technical expertise, innovations, supporting facilities, know-how, and a desire to see their innovations commercialized., the ESIC/EIR approach should be an attractive option.

For fledgling companies, the EIR model offers all of the necessary resources to help successfully build a company and enable the new endeavor to transcend the hurdles – including financial, management, strategic, and technological – that are encountered by most early stage companies.

State and federal agencies benefit not only from their responsiveness to the aforementioned public support for CE, but also from economic development (jobs, tax base) resulting from the establishment of CE companies. Furthermore, these Government investors will care because EIRs will be commercializing lab and university innovations (they would be commercializing someone else's technology somewhere else), with access to a bevy of highly talented investors.

Organizations supplying technologies (e.g. DOE/NREL and universities) benefit in that they want to accelerate their technology transfer and improve the speed and return on its R&D investments. Also, beyond a new commercialization path for their R&D efforts, they have an opportunity to showcase emerging technologies that are being developed in their labs. They will likely also have additional licensing opportunities, as their technologies, whether or not they are selected by the EIRs for commercialization, will have greater exposure and more active strategic placement than is currently enjoyed.

Investors – specifically VCs – benefit in a variety of ways from this model. VCs tend to focus exclusively on "VC-like" deals and their attendant characteristics. And while VCs are a very important part of the financial food chain, the ESIC/EIR approach that we propose is better matched (especially with the early focus on knowledgeable angels and serial business entrepreneurs) to the very early stage development of the technologies and products coming out of the labs and universities. These "raw" technologies, as well as the many nascent technology focused start-up businesses the partnership will work with, are clearly not VC-like deals. The good news is that these opportunities will not compete with VCs for deal flow, but rather they will be a source of attractive next generation deals for VCs to engage with, and invest in, as the market-focused businesses are formed and matured.

Moreover, the EIR model is not only better matched to the very earliest stages of business formation - along with the associated risk tolerance - it also does a better job of aligning incentives and attracting the best people available. To this point, most VCs don't have the time or sufficient resources for forming companies and the corresponding risk profiles are too great[31] for this very early stage. In addition, paying well enough to hire the best VCs is problematic,[32] since their salaries are relatively quite high. Further, in the case of government-sponsored venture funds (such as the In-Q-Tel genre) noted above, they are expected to deliver the government market which often takes large resources[33] resulting in high overhead.[34] This in-turn will inhibit the fund from ever becoming self sustaining. Hence, successful entrepreneurs that have built other companies and have more directly applicable experience in many cases, and who are looking for their next big deal to develop, will often cost much less early on as they have an expectation that their equity stake will more than make up the difference. Thus they are better aligned with the needs we are addressing in this paper.

EIRs have more investment personally in making the business a success, and they are looking to ultimately partner with talented VCs as the business matures. This, along with the close coordination with a robust resource network (described below) that addresses promising technology platforms from universities, NREL, and other national labs should make for a much more cost effective approach.

Finally, as mentioned in the above sections there is the need for entrepreneurial businesses (and their R&D sponsors) to tailor their companies from inception toward the kind of capital investment they anticipate needing, whether it is venture, angel, strategic industry, project, or any other type, or combination, within the financing food chain. The ESIC, with its advisory boards, uses an integrated approach that pays particular attention to the anticipated full spectrum of requirements from investors for the venture. This is particularly important in the early-seed and seed stages.

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[31] See side bar on p 13 – "What Venture Capitalists Look For."
[32] Any chosen approach should not have even the appearance of someone getting rich off of the government dime… this is difficult since VC compensation is very high.
[33] Government can be an important market for energy, especially for beach-head markets. However energy (a commodity) markets, are much broader and diverse than many other markets.
[34] According to the 2001 BENS Report of the Independent Panel on the CIA In-Q-Tel Venture, as of March 31, 2001, In-Q-Tel had received $62M in funding, of which, $15.75M was used for operational costs over two full fiscal years ($12.5M for G&A, $3.25M for market research and portfolio management), and only $2.7M was used for equity investments. When compared to a normal VC fund, which typically operate at 2-2.5% per year, it is reasonable to assume that In-Q-Tel will not be able to overcome its cost basis to reach self-sustainability, even if the fund returns in the top 5% of all funds.

Conclusions

Recapping from the above discussion, key stumbling blocks that increase risk and inhibit early-stage private sector investment include high technology and product risk, underdeveloped (and often poorly defined and understood) markets for the technology, and long times to markets. Thus, there's a need for technology and product maturation as well as market validation (T&PMV). Further, the funding gap (from when the technology comes out of the lab until the company developing the market-focused product is appropriate for private financing) associated with CE investments can be much more difficult to deal with than some investments, like software. For instance, not only are the times–to-market longer, but the size of the investment needed is often quite a bit larger and the commodity nature of energy can inhibit investor interest.[35]

The Early Seed Investment Corporation (ESIC) proposed in this report is designed with a focus on T&PMV to bridge the funding gap by engaging and aligning well with the private sector investment community and by applying strong business formation and market related disciplines to the commercialization process. ESIC, which uses Entrepreneurs-In-Residence (EIRs), which have been shown to be highly cost-effective in accelerating the transfer and commercialization of technology from the lab to the marketplace, thus serves the interests of both the private and public sector investors. In addition, ESIC is well designed to, build on and leverage state and federal resources[36] where, and when available. In addition, this approach will not only increase the yield on the public sector technology R&D investment, it will enhance the volume of market attractive deals and technology innovations in the investment pipeline which are needed for sustaining the growing investment interest in CE.

More specifically, ESIC/EIR is a public-private partnership that gets investment decisions unambiguously into the hands of real private sector investors, who will both inform and drive the process in the marketplace. This is primarily because the ESIC/EIR also promotes partnerships with a spectrum (or portfolio) of investors, including angels and strategic industry partners early on, with both the entrepreneurs and public sector sponsors. This is important since these partnerships can lead to more effective financing which involves sharing and allocating risks with those best prepared to accept (and understand) those risks.[37]

In this regard, ESIC/EIR helps fledgling companies, and their R&D sponsors, understand and address how investors view risk and the nature of the risks with which private sector investors are most concerned. Specifically, ESIC/EIR helps entrepreneurs define and tailor the preferred funding and commercialization trajectories for their companies from inception, for the kind of capital investment they anticipate needing, whether it be (any combination of) venture, angel, strategic industry, project, or other kind of financing. Moreover, it helps entrepreneurs and their public sector sponsors develop an understanding of the most strenuous tests that investors will put them through before writing checks. This is important since investor needs will vary from

[35] The much smaller amounts needed often let start-ups in software preclude the need for venture, and sometimes even angel financing.
[36] This includes a range of mechanisms such as the Other Transaction Authority described above.
[37] For instance, while VCs are willing to take some technology risk, project financiers will not take any.

one investor type to another, as will the venture's needs depending on where the venture is in the commercialization process.

A key reason that the ESIC/EIR approach has the potential to increase the speed and application rate of innovation coming from the labs and universities, is that the market insights from private sector investors can be more rapidly absorbed by the EIR led companies; ESIC/EIR emphasizes market driven, technology pull from labs and universities. Thus we believe that success will breed success at the participating labs and universities as well as at the public sector sponsoring organizations, and encourage a growing support base for more effective R&D that is tightly coupled to viable commercialization and financing trajectories.

Moreover, the entrepreneur-in-residence (EIR) approach, aligns the needs and objectives of labs, lab sponsors, and private sector investors, along with those of the marketplace quite well. For example, it will assure the involvement of quality investment professionals and organizations by ultimately providing returns to the professional investors that are commensurate with private sector opportunities. In addition, ESIC will have access to, and the ability to align with a robust resource network that also supports the development of a wide range of CE and related infrastructure businesses.

Also, the ESIC/EIR model can provide a direct connection and contribution to local economic development including the creation of jobs associated not only with the EIR companies, but also with the additional infrastructure businesses that will result.

Finally, we believe that the ESIC/EIR model will provide a much needed and quite valuable new paradigm for moving market attractive technologies and innovations from the lab to the marketplace. The approach does this while much more effectively engaging the private sector financial community with entrepreneurs, and public sector investors, as well as serving a whole range of local economic development, energy security, and enhanced environmental quality needs.

Glossary

Angel or Angel Investor - An individual who provides capital to one or more startup companies. Unlike a partner, the angel investor is rarely involved in management. Angel investors can usually add value through their contacts and expertise.

Carried Interest - A share in the profits of a private equity fund. Typically, a fund must return the capital given to it by limited partners plus any preferential rate of return before the general partner can share in the profits of the fund. The general partner will then receive a 20% carried interest, although some successful firms receive 25%-30%. Also known as "carry" or "promote."

General Partner (GP) - The partner in a limited partnership responsible for all management decisions of the partnership. The GP has a fiduciary responsibility to act for the benefit of the limited partners (LPs), and is fully liable for its actions.

Incubator - A company or facility designed to foster entrepreneurship and help startup companies, usually technology-related, to grow through the use of shared resources, management expertise, and intellectual capital.

Investment Banking - The practice of raising money for companies. Common methods of capital raising are IPO's, private placement of stock, bond offerings, and other methods. Investment banks assist public and private corporations in raising funds in the Capital Markets (both equity and debt), as well as in providing strategic advisory services for mergers, acquisitions, and other types of financial transactions. Investment banks differ from commercial banks which serve to directly take deposits and make commercial and retail loans.

Limited Partner (LP) - An investor in a limited partnership who has no voice in the management of the partnership. LP's have limited liability and usually have priority over GP's upon liquidation of the partnership.

Mezzanine Financing - Late-stage venture capital, usually the final round of financing prior to an IPO. Mezzanine Financing is for a company expecting to go public usually within 6 to 12 months, usually so structured to be repaid from proceeds of a public offerings, or to establish floor price for public offer.

Mezzanine Level - Mezzanine level is a term used to describe a company which is somewhere between startup and IPO. Venture capital committed at mezzanine level usually has less risk but less potential appreciation than at the startup level, and more risk but more potential appreciation than in an IPO.

Warrant – A security that entitles the holder to buy or sell a certain additional quantity of an underlying security. This transaction takes place over an agreed-upon price, exercised within a period of time and at the holder's discretion. The right to buy the underlying security is referred to as a call warrant; the right to sell it is known as a put warrant. In this way, a warrant is very similar to an option. When a warrant is exercised, a new share of stock is created, whereas when an option is exercised, the owner of the option receives an existing share that is delivered by a counter party (except in the case of employee stock options where new shares are created and issued by the company upon exercise).

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Appendix A: Getting from Discovery to Commercial Success

The US DOE laboratories and facilities have a heavy emphasis on licensing to, and helping existing businesses by providing technology and other know-how support, as well as making facilities available rather than creating businesses. DOE has recently published (2006) a good amount of data on its technology transfer processes and results.

For example, the 2006 report provides macro-level data for FY05 from its 22 labs and major facilities; this includes data on invention disclosures (1776), patents issued (467), active licenses (5677), and the resulting revenues ($25M). Moreover, though the DOE does track and provide a good number of anecdotal success stories, and the level of success of its innovations can be inferred from the revenues, it in general does not directly track the commercial success of the resulting licenses or the licensees. A similar situation exists for many university organizations.

Stevens and Burley (1997 and 2003), however, do provide data on getting from idea to commercialization for new product development within industry as well as on project and venture capital results. They note that it takes about 3,000 ideas for one commercial success (.033%). Of these 3,000 ideas about 112 (~3.7%) are patented; and the percentage of commercial successes based on the number of successful patents is about 1% (1 out of 112 patents, which they describe as "crown jewel patents"). In addition, their analysis of government patents indicates a similar result; e.g., about 1% are clearly economically successful.[38]

When looking at venture capital investments, Stevens and Burley (1997) indicate that of these 3,000 ideas, about 120 would receive serious evaluation (e.g., ~ 4 hours of analysis by the VC firm). And of those 120 ideas (all of which must have a reasonably good business plan), nine will receive funding and one will be a commercial success, which is consistent with the industry data; that is 1 out of 120, or somewhat less than 1% is a "crown jewel." In addition, Zider (1998) provides data that show that about 10% of VC investments have very strong returns; this 10% is close to the 1 out of 9 or 11% cited by Stevens and Burley for what they call "crown jewels."[39]

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[38] Using a parallel analogy to the Stevens and Burley analysis, and for our purposes here, one can assume that the technologies coming out of the labs will have successfully received patents; and correspondingly about 1% will be a commercial success.

[39] Zider (1998) and others indicate that VCs look at about 100-150 business plans for each one they fund, while about 60% of their investments have negative or nearly zero returns.

U.S. Department of Energy (April 2006) “Annual Report on Technology Transfer and Related Technology Partnering Activities at the National Laboratories and Other Facilities, Fiscal Year 2005”. Office of Policy and International Affairs. U.S. Department of Energy.

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Appendix B: Key Characteristics & Perspectives of Public and Private Sector (primarily VCs) Investors[40]

	Public Sector Investors	*Private Sector Investors*
Key goals	• Develop promising technology options that meet public sector needs by reducing early technology risks that private sector investors would otherwise not assume	• Profitable investments in technology-based businesses that address real market needs—technology neutral within the context of meeting customer needs
Investment focus	• Technology focused development of high quality innovations: o Early, high risk RD&D o Technology performance o Technology certification, and performance verification	• Early, prudent investments in market focused businesses that emphasize: o Strong management teams o Products - not technologies o Market development and access to these markets; customer driven
Biggest concern	• Technical show stoppers	• Customer and market showstoppers
Other key contributing investor insights / expertise / strengths	• Technology based perspectives on: o Capabilities, benefits, and applications o Technical competition • Macro market perspectives on energy and trends • Perspective on public policy and public good needs & trends, as well as the potential to impact • Standards development	• Business and Financial perspectives on: o Market driven, customer benefits o Broader (beyond energy) sets of industry applications o Market competition • Specific market perspectives and trends for energy and other applications including market, beachhead, and entry strategies • Ability to factor public policy impacts into investment and business formation decisions effectively
Key constraints on collaborations	• Investment collaborations must abide by governmental regulations including fairness of opportunities, and not compete with the private sector • Commercialization viewed as responsibility of private sector	• Investment collaborations should reduce the risk and improve the profitability of investments
Key enablers needed	• Collaborations that accelerate the deployment and use of the technology in which the public sector invests; private sector exercises their option to invest	• Access to the information, people, knowledge, and data necessary for sound investments • Entrepreneurs that are predisposed to, and/or already focused on market /customer product and business development issues
Differences in funding process	• Competitive written proposals judged mainly by a technology focused review team; decisions sometimes appealed • Non-Disclosure agreements (NDAs) not unusual	• Final decisions base on oral presentations by management team; supported by extensive due diligence; non-recourse decisions • NDAs never used

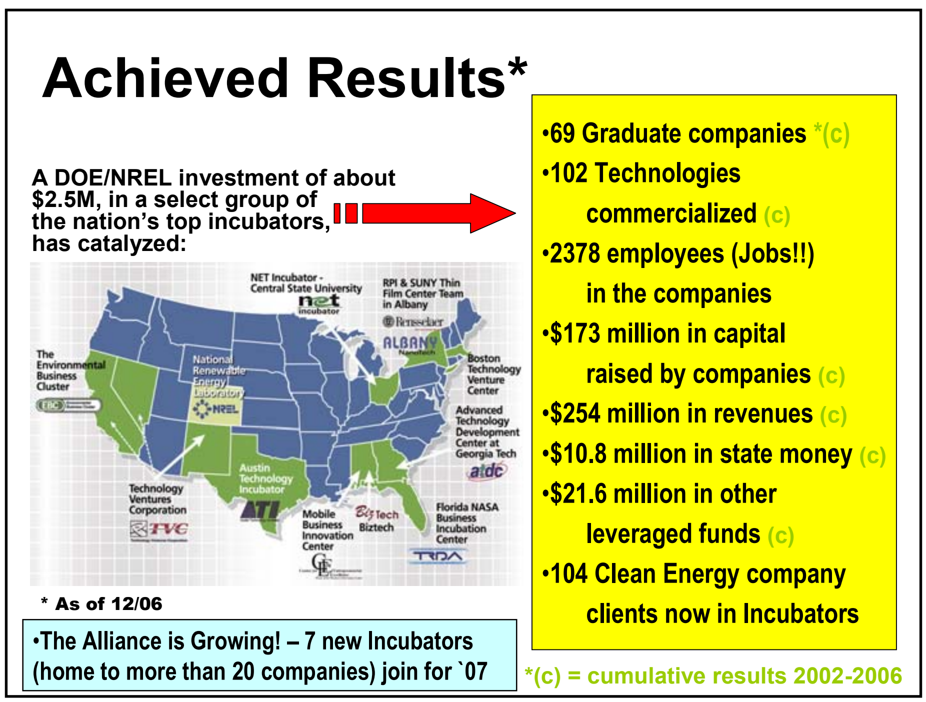
[40] From Murphy and Edwards (May, 2003)

Appendix C: The Clean Energy Alliance Incubator Survey Summary

The yearly incubator survey tracks several quantitative figures that help paint the picture of how successful the program is. The number of companies, employees, revenue totals, and capital raised describe how the entire program is functioning and the impact it is having on the development of the clean energy industry.

The Clean Energy Alliance[41] is dedicated to helping startup and developmental clean energy businesses grow. Clean Energy Alliance Incubators help client companies refine their business cases and develop their enterprises, thus making them more attractive to private sector investors. Through this, the Alliance helps provide a larger source of lower risk investment opportunities for private sector financiers, while simultaneously providing jobs and economic development for local regions, providing higher yield on R&D investments made by public and private sectors, and providing more rapid and certain commercialization of clean energy technologies.

The 102 commercialized technologies developed within the Alliance are proof that businesses based on perceived high risk clean energy technologies and innovations can become successful in the marketplace if they are provided the appropriate guidance and resources to better align them with private sector investors and marketplace needs.



There are currently 104 clean energy companies from all over the country participating in the Clean Energy Alliance. Participation ranges from companies that are physically located in the incubator to companies who receive assistance and guidance via a virtual relationship.

These 104 companies employ 2,378 workers dedicated to the development of clean energy technology. There are also 69 graduate companies that no longer require incubation services and are self-sufficient. And since we don't track the number of employees in these companies once they leave the incubator, the employment picture is considerably stronger than presented here.

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[41] The Clean Energy Alliance, was recently formed as a not-for profit 501(3)c corporation, based on what was called the National Alliance of Clean Energy Business Incubators (NACEBI).

More than $173 million in capital has been raised by clean energy startups over the four-year period. This includes both public and private capital in the form of angel, VC, SBIR, grants, and other unique investment forms. For all their work, these clean energy startups have generated over $254 million in revenue – inclusive of royalties on technologies.

Another important factor is the money leveraged by the incubators. Over the three years that have been tracked, incubators have received $39.2 million from federal sources (usually passed through state level initiatives and organizations), $10.8 from state sources, and $21.6 million from other sources (private, city, county, etc.) This money helps to facilitate the incubation process and provide an additional catalyst for the profitable commercialization of clean energy technology.

The mission of the Clean Energy Alliance to provide clean energy technologies, emerging from both public and private research facilities, the necessary expertise, network, and support to make the leap from the laboratory to the market. Having supported the commercialization of 102 technologies in the last three years, the Clean Energy Alliance is confident that an even greater number of technologies will emerge from a growing list of incubators in the coming years to bring systemic change to how energy is created, utilized, and understood.

Beginning in 2007, the Clean Energy Alliance will welcome 7 new incubators. Spanning the country, these new incubators already house over 20 promising clean energy technology companies that will soon reach commercialization and contribute to the growth and impact of the clean energy space. These incubators include:

Blue Hill Partners, LLC of Philadelphia, Pennsylvania

Clean Energy Innovation Center of Denver, Colorado

CleanStart – McClellan Technology Incubator of McClellan, California

Enterprise Center of Johnson County, of Lenexa, Kansas

Ignite Technology Ventures, LLC of Boston, Massachusetts

Northwest Energy Technology Collaborative of Seattle, Washington

Rutgers EcoComplex of Bordentown, New Jersey

Appendix D: The NREL Industry Growth Forum—Summary of Investment Results for Presenting Companies at the NREL Industry Growth Forums 14-18

PROCESS

In order to paint a better picture of the success stories resulting from NREL's Industry Growth Forums, we began tracking the financial investments received by presenting companies at each forum, from the 14th onward. While many criteria can be used to gauge the growth and effectiveness of the forum, the total investment received by presenting companies reveals interesting characteristics about not only the forum itself, but also the current financial climate in which clean energy entrepreneurs operate. As a result, it continues to be the most requested and popular measure for forum success. Investments into presenting companies are comprised of both those made by the "private" sector (including private equity financing, mergers, acquisitions, and IPOs) and those made by the "public" sector (including government grants, subcontracts, and relocation incentives).

We used an eclectic process of gathering information which included strong reliance on press releases, company Web sites, and other electronic media. We recorded and documented investments only if supporting documentation could be found to confirm the existence of such funding. References to these supporting documents are included in NREL's database of forum metrics. In an effort to deduce significant information regarding the average duration between a company's presentation and the time at which it received funding, the $USD amount of investments received by presenters was recorded for each company receiving an investment and the number of months since that presentation duly noted. Investments made in companies presenting at more than one forum were attributed to and recorded for the earliest forum at which the company presented. Aggregate investments only are reported for all presenters at each of the 14th, 15th, 16th, 17th, and 18th forums. The total amount of investment recorded since the 14th forum is also reported.

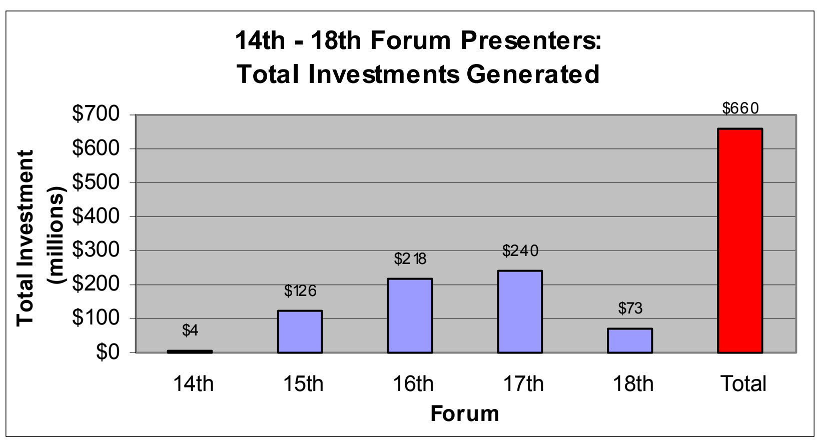

Figure 7. Total investments received

RESULTS

As of November 1, 2006, we have accounted for a total of 85 distinct investments, totaling approximately $660M (million), in the companies that have presented at NREL's 14th through 18th Industry Growth Forums (see Figure 7).

Of this $660M, approximately $571M, or 86%, was raised from the private sector, while the remainder was raised from public sector sources. NREL recorded 44 distinct private sector investments, including 39 private equity raises and 5 IPOs, indicating the majority of presenters remain early- to mid-stage companies prior to the infusion of additional capital. The average size of these private sector investments is $12.97M and the median investment is $3.5M, indicating the distribution is skewed by a few large investments). The mean and median of the 41 public sector investments are $2.18M and $750K (thousand), respectively, also indicating a positively skewed public sector distribution.

It is encouraging to note that a wide variety of technology types have been represented among those companies receiving investments. 29 of the investments reported were made into photovoltaic companies, 11 into fuel cell or hydrogen technologies, and 8 into companies developing communication and control technologies. Fewer investments were made into ocean/wave energy, biomass, and energy efficiency and storage companies. Only four investments were made into wind power, indicating the mature nature of the wind industry for large turbines from an investment perspective. The remainder of the investments were distributed among a wide range of other technologies including advanced materials, design software, Stirling engines, and other energy conversion technologies (see Figure 8).

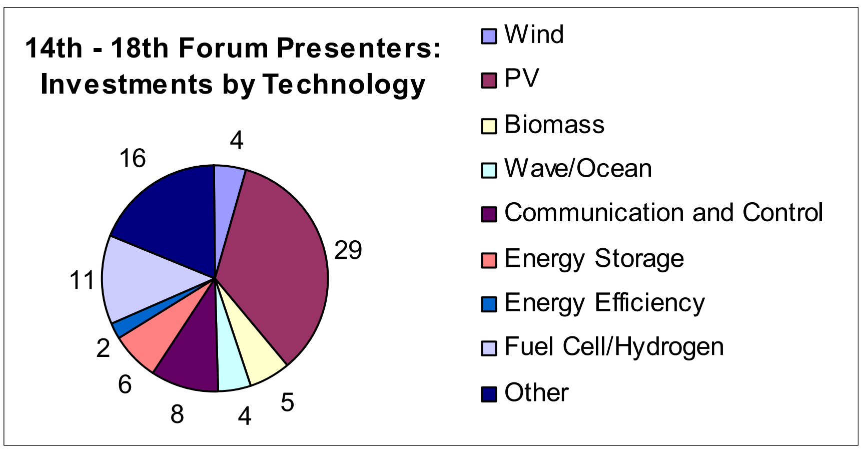

Figure 8. Investments by technology type

The investment raised by presenters at the 14th forum totaled approximately $4M, while that raised at the 15th, 16th, 17th, and 18th forums summed to $126M, $218M, $240M, and $73M respectively. It is important to note that only 17 companies presented at the 14th forum, which was held October 31st, 2001 at the height of the post-tech bubble, U.S. economic recession. Shortly after the 14th forum, NREL initiated a major effort to upgrade the presentation and mentoring process of the event. Subsequent forums witnessed at least two times as many presenting companies. Limited data received for the 14th, 15th, 16th, 17th, and 18th presentations indicates the average duration of time between the date of funding and that of a company's presentation is approximately 14 months.

We, therefore, can extrapolate that investment in companies presenting at the 16th forum should peak by late calendar year 2005. In light of the fact that average time to investment for the 14th, 15th, 16th, 17th, and 18th forums was 22 months, 22 months, 15 months, 8 months, and 5 months respectively, we have reasonable reason to believe that the duration of time between a company's presentation and subsequent funding may be decreasing.

One of the clearest indicators of entrepreneurial success, of course, is the successful navigation of a company through an IPO, a merger, or an acquisition. Five companies presenting at NREL's forum have benefited from major IPO events. Most notably, Clipper Windpower recently closed a public offering totaling $135M on London's AiM stock exchange in October of 2005. Daystar raised approximately $10.5M in February of 2004 and ZBB Energy raised over $4.5M in March of 2005. While IPOs are typically well-documented by the press, our understanding of mergers and acquisitions subsequent to forum presentations is less clear. We know, for example that Mesofuel, which presented at the 16th forum, was purchased by Intelligent Energy, though the price (while unconfirmed at $10M) is uncertain. Similarly, Unisun, which presented at the 14th forum, was purchased by Nanosolar, though no price has been given. Later reports indicate Nanosolar raised some $20M after this deal. It is not clear just how much of this raise is attributable to Unisun. Additionally, Chameleon Optics was acquired by Micron Optics for an undisclosed sum, Solectria was acquired by Azure Dynamics for an alleged $20M and MicroPlanet merged with HF Capital for an alleged $8.1M (see Figure 6). The characteristics of mergers and acquisitions are often difficult to define given the nature of their complex terms and often varying structure which can include intricate equity and capital exchanges, rapidly shifting stock prices, and non-disclosure safeguards.

Appendix E: Public-Private Partnerships to Reduce Risk

As noted above it also turns out there is a lot that can be done (and a good deal that is being done) to help reduce the real and perceived risk to the investor, especially early on. First and most importantly, by sharing the risk through joint resources (both expertise and financial) as appropriate, risk to all participating parties will be reduced. This includes making specific investments around technology and product maturation. It also includes doing a much better job of understanding and addressing the interfaces with anticipated subsequent investors. Though these efforts are somewhat piecemeal; taken in total, they indicate recognition at both the state and national level of the problem. Further, all of these engage public and private sector participants to reduce risk.

We provide a sampling of key examples from the states and from the federal government; most of which help to reduce technical and related early product risk.

State Initiatives

A number of states have recognized the need for technology maturation, and have created mechanisms to address this issue. They all vary in size of efforts and focus, as well as degree to which they engage private sector investors and small technology businesses trying to commercialize their technology. They also vary in the level of coordination with the federal sector efforts. States, it turns out, often have much more flexibility in their commercialization efforts vis-à-vis the federal sector. Moreover, the state initiatives are often focused on job growth and economic development. One common feature among the state programs is that they are relatively new, often having been created in the last five or so years.

For instance, the Massachusetts Technology Collaborative (MTC) has created a Sustainable Energy Economic Development program to make direct investments in companies that have yet to demonstrate commercial viability. It helps bridge the gaps between innovation, seed, and venture investments. It is currently an $8M initiative with $2M in the FY 2005 round. It provides low-interest, $50K-$500K convertible loans (to equity). Another MTC program is the Green Energy Fund. MTC has committed $15M, as a lead limited partner in a $25M fund with VCs; investments up to $500K have been made (Funk 2005).

In another example, Wisconsin, through a non-profit company - CleanTech Partners, Inc. – has sought to address the funding gap by providing investments, business expertise, and Wisconsin sales leads to companies that have developed new energy-saving technologies. Founded in 2003, CleanTech Partners, a $3.5 M investment fund, is supported primarily by the state's Focus on Energy program. The fund has a variety of investment structures – equity, debt, and hybrids – tailored to a company's need. CleanTech Partners-funded companies must show that their energy technologies will have an impact in the State of Wisconsin (among other places). See Appendix D for an example case study of a CleanTech Partner investment that benefited the NREL Growth Forum.

Another state, California, has created a number of mechanisms over the years to address the technology maturation problem. Beyond its current Public Interest Energy Research Program, which has many parallels with the NREL collaborative R&D process for developing new energy innovations, they have created a Small Grants Program for Energy Innovations operated by San Diego State University for CEC (Deangelis 2005). It can be used for technology maturation as well as creating new innovations. It has a $100K limit.

More recently in California, the California Clean Energy Fund (CalCEF) was created in June 2004 as a nonprofit public benefit corporation dedicated to making equity investments in CE technology and service companies. CalCEF's initial endowment of $30 million comes from a utility bankruptcy settlement with the shareholders of Pacific Gas & Electric (PG&E), a California utility company. Other than providing this initial capital, PG&E has no control of or involvement with CalCEF. CalCEF was created with the goal of stimulating private sector investment in CE companies in order to provide market-based financial returns to shareholders and positive environmental and economic returns to the state of California. It is hoped that the fund will advance the commercialization of CE technologies and services within the state.

CalCEF capitalizes on various unique attributes that position it to successfully meet its objectives. Its board of directors—composed of policy makers, investment professionals, entrepreneurs, and technology experts—champions an investment philosophy that is closely aligned with major policy drivers and recent advancements in energy technology. This enables the fund to more closely monitor emerging CE markets and to proactively make sound investment decisions.

CalCEF has unique relationships with three well-established venture capital managers—VantagePoint Venture Partners, Nth Power, and Draper Fisher Jurvetson—each which provide a unique and complementary perspective on energy technology markets. CalCEF has allocated $8.5 million to each fund. These managers also will match each dollar invested on behalf of CalCEF based on discretionary criteria typical of their individual management practices. For example, Nth Power typically likes to own 10%-15% of a company and aims for 5-10 times or even greater return on its investment from a company with a technology proven at the lab level and ready for a product launch. Funds are invested in private companies creating technologies or products that will lead directly or indirectly to decreased reliance on non-renewable fuels. Both early- and late-stage equity investment opportunities are eligible.

CalCEF is also working to establish an angel network of investors to fund promising companies that might need additional to support before they can meet CALCEF's investment criteria. Finally, CalCEF is an example of a U.S. trend to use a utility settlement of compliance payments to create new funding mechanisms for clean energy.

States also support business incubation programs, primarily for job creation and economic development, and they increasingly see clean energy as a good focus area. Texas, California, New York, and six other states are part of the NREL-created NACEBI (which has now become the Clean Energy Alliance; see Appendix C) . And although these incubators cannot solve the technology maturation problem by themselves, they are quite valuable in helping bridge the valley of death in a number of ways. For example, these incubators often encourage their entrepreneur-client companies to take advantage of federal opportunities (described below), often aggressively helping their client companies engage with these opportunities. Further, these and other quality incubators provide access to some of the best business development insights available, and they provide a wide range of contacts and connections to financial and other strategic partners.

University Initiatives

A number of universities have created technology incubation programs such as those at the University of Texas at Austin and the Venture Lab at Georgia Tech/Advanced Technology Development Center (ATDC) that nurtures and matures the technology within a start-up company to prepare them for business incubation. For example companies within Venture Lab, if they pass muster there, are expected to move into the ATDC Business Incubator as a next step in the commercialization process. Another example of technology maturation is in the state of New York at ANT which combines business incubation processes with extensive prototyping capability (primarily in the semiconductor and nanotech areas). ANT also works closely with its client companies to align them with other state funding resources that are designated to foster the growth of these companies in New York.

Federal Programs for Technology Maturation

DOE National Labs. DOE and its federal labs create a good deal of technology. And the DOE has a wide range of technology transfer programs aimed at moving their technology out of the laboratory; there is a heavy emphasis on licensing of intellectual property.[42] In addition, some labs have a limited capability for technology and product maturation; but in most cases, as explained in the main body of the report, these labs are a source of technology, but not technology ventures that are ready for private investment. NREL is the one DOE (or federal) laboratory that is totally focused on CE technology development and in the past has used approximately half of its budget for collaborative R&D with groups of industry (both large and small) and university partners. Yet because of our mission directives and federal requirements, technology and product maturation funds are often not available; and there are no efforts focused directly on market validation.

Also of note is that most of the labs have what is called entrepreneurial leave opportunities, that allow scientists to leave the lab for a period of time to help start up, or assist in a the start-up of a company; but to then return to the lab within a certain time period. These "leave" programs have various, names, and operational requirements, as well as return policies depending on the lab. Though some investors do not like folks on their team having such a safety net, this approach can however be a great way of transferring technology to the private sector, as well as bringing private sector perspectives back into the lab if the employee returns to the lab.

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[42] US Department of Energy (April 2006) "Annual Report on Technology Transfer and Related Technology Partnering Activities at the National Laboratories and Other Facilities, Fiscal Year 2005". Office of Policy and International Affairs. U.S. Department of Energy.

SBIR. The most common federal programs applicable to technology and product maturation that will lead to commercialization are the SBIR and the Small Business Technology Transfer (STTR) programs. They each allow two phases: up to $100K for phase 1 and $750K for phase 2 proposals. In terms of dollar volume, these programs constitute the largest federal programs directly aimed at the commercialization of technologies developed by small businesses.

Many government agencies have SBIR/STTR programs, and the calls for proposals are usually (not always) at periodic and regular intervals. These calls for proposals often focus on specific technology areas of most interest to the specific agencies. SBIR requires the lead organization to be a small business; though commercial and government partners in support of the small business are often part of the equation. STTR also requires the involvement of a federal research facility. The downside of these programs is that the cycles of interest and funding in particular areas can be fairly long. There is a wealth of information on the Web about these programs.

ATP. Another important federal level program is the U.S. Department of Commerce's Advanced Technology Program (ATP), which was established by the Omnibus Trade and Competitiveness Act of 1988 to fund early-stage, high-risk research that would likely be deferred if not for government support. Like Massachusetts' and California's maturation funds described above, the mission of the ATP is to move new technologies from the laboratory into the marketplace by providing funding for navigation through the "valley of death," often referred to as the period of time bridging successful laboratory demonstration and commercial feasibility of new technological concepts.

The ATP serves as an excellent example of a maturation fund that has ironically received criticism for the potentially inappropriate use of public funds, primarily a result of its funding of late-stage research often conducted by large firms with seemingly adequate resources to advance their technology independently. Despite such concerns, the program continues to play an important role among federal investment in the development of science and technology. An independent study performed by the National Research Council found the ATP to be highly effective with significant beneficial impact to federal investment in basic science and technology. The ongoing budget battles illustrate the disagreement among our legislators on whether the federal government should sponsor later-stage R&D. The ATP budget has repeatedly been zeroed out and then restored.[43]

To further the ATP's impact, the U.S. Department of Commerce recently has suggested various reforms to the program. Among them, to specifically fund high-risk ventures and to help dispel the notion that the program supports only late-stage research, the Department hopes to encourage reinvestment of a percentage of revenues derived from past awards back into the ATP. Such reinvestment monies would result from royalty payments from previously successful investment recipients. The monitoring of program management activities is also recommended to prevent the support of product development and marketing efforts from ATP funds, as these fields are generally not the proper domain for government funding. Finally, a more thorough analysis of

[43] Aspects of the ATP have been used as the blueprint for designing high-tech industrial support programs in a number of competitor countries, including Taiwan, Australia, France, Germany, Japan, the Netherlands, Switzerland, and the United Kingdom. "So why, a reasonable person might ask, are we trying to kill what other nations are trying to copy?" asked Sen. Jeff Bingaman, D-NM.

product and market considerations is recommended during the review process used for selecting funding recipients.

Dual Use: Another example of public-private partnerships evolved from the "dual use" requirement pioneered by the DARPA, (and now much more widespread) within the U.S. Department of Defense (DoD). The DoD looks for technologies that have commercial applications, as well as those meeting military requirements. Thus additional applications and markets for the technology are identified, making technology investments by the private sector less risky while providing relatively high-margin beachhead markets for entrepreneurial ventures and leveraging a much larger base of related commercial R&D—especially when the deals are syndicated. Of course, relatively few of these programs are focused on energy, but when they are, this is an additional opportunity for small CE companies.

A recent article by Bonvillian (2006) describes the background of the Defense Advanced Research Projects Agency (DARPA), its history, and its "secrets" of its success in fostering innovation and filling the pipeline with breakthrough inventions – including DARPA's 12 key organizing elements. Bonvillian also talks about, and endorses a DARPA spin-off concept called ARPA-E which would be focused on Energy; ARPA-E has been discussed recently in a number of venues including the National Academy of Science in a recent 2006 report *Rising Above the Gathering Storm*, and by various legislators, as well as by the popular press.

Hybrid Venture Funds.
An innovative public-private partnership concept that has gained ground with several government agencies is the government-sponsored VC fund, whereby public agencies fund an independent, private, nonprofit investment firm. The first such enterprise was In-Q-Tel, established in 1999 with backing from the CIA and later expanding to include additional, undisclosed, partners from other Intelligence Community agencies. The U.S. Army has structured a similar fund (On-Point), as has NASA (Red Planet).

These hybrid funds blend equity investments and development funding for specific projects to young companies to create commercially-available products that also meet the particular technical needs of the sponsoring agencies.

Another model of a public-private partnership is provided by Battelle Memorial Institute (BMI). BMI is a non-profit corporation and has a long history of commercializing technology. It also operates and /or shares in the management & operation of a number of DOE labs such as ORNL, NREL, and PNNL; i.e. they are a Management and Operations (M&O) contractor for the DOE.

Several years ago, BMI created Battelle Ventures (BV), which is a for-profit Venture fund. BMI is the sole limited partner to Battelle Ventures (BV). BV operates like a traditional Venture fund and has a standard 80/20 profit sharing relationship with BMI; while BV gets a management fee and 20% share of net profits from the cash-out of their equity investments, BMI gets their investment back, and 80% of net profit which in turn is reinvested in laboratory in infrastructure, in a way that is consistent with their non-profit status.

BV is an early stage venture fund, and is currently a modest sized fund of about 150M$; and it seeks syndication partners for all of its deals. BV has three technology foci; software, Bio devices and energy, and they look at technologies coming out of the labs for potential deal flow, but are not limited to labs. In addition, BV have been exploring a number of innovative approaches for getting technology out of the lab and into the market place – such as building a company around a specific technology that they identified in one of the labs – in an approach which is consistent with the entrepreneur-in-residence approach described later in this report.

Small Business Investment Corporations (SBIC) and Specialized Small Business Investment Corporations (SSBIC) are primarily lenders that borrow money from the Small Business Administration (SBA). These investment corporations, first created in 1958, are licensed by the SBA and offer another form of public/private partnerships. There is a large amount of money available (e.g. there is currently about $21B under management in approximately 400 SSBIC and SBICs). Also these investment corporations can borrow an amount up to 3X the amount of private money that they raise. In addition, though these investment companies and the SBA, have less stringent collateral requirements than commercial banks, the interest required by the SBA can be quite high to account for this extra risk.

This type of debt funding[44] can be quite attractive for expansion capital and later stage ventures that have solid cash flow to service a significant amount of debt though it does not appear to be particularly relevant to "cash flow poor" seed and other early ventures. Examples of Venture Capital firms that are licensed SBICs include: Chrysalix Energy LP, Rockport Capital Partners, and DFJ New England. In addition, SBICs are active in project financing such as within the Federal Energy Management Program, as well as with Brownfield and wind projects.[45]

Looking Beyond the United States

While we have been following In-Q-Tel almost from inception in 2002 (Murphy and Edwards 2003), along with others in the United States who are carrying out similar efforts, there are a good number of financial innovations occurring beyond the U.S. shores. These innovations are being driven by the both the desire and need to get a better return on the R&D investment, as well as the need to get them into the marketplace for solving specific problems, such as those addressed by CE technologies. For instance, Imperial College in London recently reported:

> "Imperial College London has joined with Amadeus Capital Partners, the European technology investor, in a GBP 250,000 project funded through the DTI's Knowledge Transfer Partnership (KTP), to research and commercialize new energy and environmental technologies emerging in the UK. This pioneering partnership is the first time that a KTP has been set up between a university and a venture capital firm."

[44] Although, the investment corporations lend the money to their portfolio companies, they sometimes take partial repayment in the form of equity.
[45] There is a wealth of information on the Web; see for example: http://www.entrepreneur.com/article/0,4621,300803,00.html and http://products.cerc.com/brinfo.nsf/ALL/1626EA1B996564DB85256A8D004B5CA9?OpenDocument

Appendix F: Case Study of Successful Gap Funding in Wisconsin

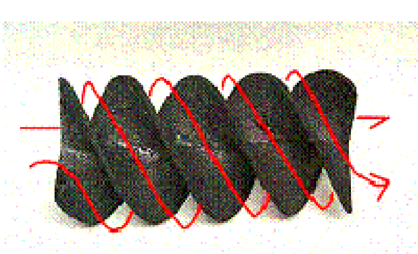
CleanTech Partners (described above under State Initiatives) initially identified Spinworks as an investment candidate at NREL's "Industry Growth Forum" in November, 2004 in Orlando, FL. Founded in 2001, Spinworks is located in Erie, PA. It had developed and started to market an energy-saving product, SpyroCor, for use by the heat-treating industry. The company predictably was unable to raise money from institutional venture capital firms. Its innovative technology does not have the potential to drive Spinworks to the $50-100 million valuation favored by VCs. Nonetheless, the technology will support a company with perhaps $5-10 million in sales and save energy and reduce costs in the heat-treating industry.

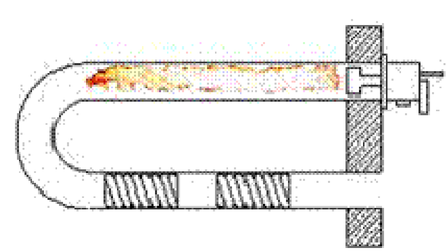
SpyroCor was developed in part using funds provided by the New York State Energy Research and Development Authority, with additional funding provided by two different Pennsylvania economic development agencies. The company also obtained an SBIR Phase 1 grant from DOE. Spinworks had six installs, all close to home geographically. There were no installs in Wisconsin nor in Pennsylvania and New York (the initial providers of research funding). In the case of Wisconsin, Spinworks had made no sales calls in the state, despite the fact that it is about the number 10 state in the country for heat treating and two of the four company founders were Wisconsin natives.

Spinworks is a small company with solid, but relatively inexperienced management. It needed capital to expand its manufacturing operation and marketing efforts as well as to develop additional energy-saving products. Wisconsin heat-treaters were unaware of Spyrocors despite their initial sales, and with no independent verification of the technology or the vendor, Wisconsin firms were unlikely to try Spyrocors and put their processes at risk.

While most states support technology development, very few support commercialization activities like Wisconsin. After extensive due diligence, CleanTech Partners elected to make an investment in the company. A $350,000 revenue-linked financing from CleanTech Partners is being used to hire a sales representative focusing on Wisconsin and to help Spinworks expand its business and product offerings. Once verification of energy savings was completed, Focus on Energy was also able to provide incentives to eligible industries that installed the technology.

Spinworks plans to introduce two additional products (HeatCor and FireCor) over the next three years. HeatCor is a ceramic heat exchanger and FireCor is an entire tube replacement system. Combined, the SpyroCor, FireCor, and HeatCor products can reduce fuel consumption by over 50%, with six to twelve month paybacks. As of July 31, 2006 there have been 15 installs in Wisconsin with more planned and Spinworks began making payments to CTP.

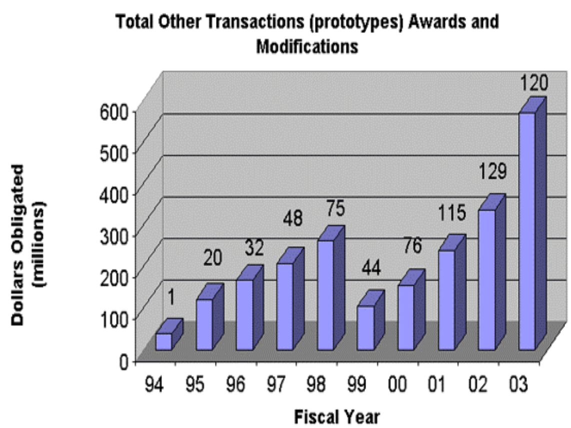




Appendix G: Other Transactions Authority and EPACT 2005

EPACT 2005 has allowed for, and encourages the use of Other Transactions Authority (OTA)[46] which could have a significant impact on supporting the technology and product maturation in particular of DOE sponsored innovations. This mechanism has been used quite successfully by the US DoD; specifically for prototype development. In particular, Marguth (Nov. 2004)[47] has provided a summary that indicates that this authority has been shown to be considerably more effective than say the Cooperative Research and Development Agreement (CRADA) process for the DoD when applied to prototype development.

The DOD Experience. In particular, the DOD has successfully used this authority to fund projects to develop prototypes that are directly relevant to weapons or weapons systems and are proposed to be acquired by the DoD. Cooperation between the prototype developers and the DoD is not only allowed, it is expected. And while project funding by DoD is not limited, the developer may need to fund up to one third of the cost. In addition the prototype proposal may include funds for a follow-on production run.



Moreover, while the Government can pay up to 50% for a research project it can potentially pay for more than 2/3 of the cost for a prototype development. In addition, the non-duplication of efforts for research-type OTAs do not apply.[48] The use of this tool is shown as function of time in the attached figure; the dip, and subsequent rise in the ’99 time frame corresponds to when CRADAs came out of favor as a highly effective tool by the DOD.

Benefits include the fact that research firms and developers of products who chose not to be contractors to the Government under Bayh-Dole acquisition regulations could be attracted as OT contractors. In addition the DoD has expanded its potential supplier and R&D base to include new parties who were reluctant to perform work under, say federal acquisition regulations (FARs). Given all the above, OTAs authority is now a valued T2 tool!

OTA and ESIC. OTA, based on the successful DoD experience for prototype development, can meld effectively and productively with the Early Seed Investment Corporation (ESIC) concept, as a way to fund prototype development. In particular, it is well matched to the need to support technology and product maturation as well as market validation (e.g. using the prototypes to gage market acceptance and needed market adaptations). In essence OTA is another tool that ESIC and the Entrepreneurs in Residence can use to accelerate the movement of technology out of the

[46] See Section 1007 of EPACT 2005 (HR 6-339)
[47] See Marguth, Gib. (Nov. 2004). DOD ***Technology Transfer “Tools” and the Legal Issues.*** Proceedings, FLC E&T Training. TTIP Conference, pp 17-20.
[48] However, the developers financial records may be subject to examination for projects exceeding $5 million.

federal or private labs, and commercialize it; it is a more robust tool than say SBIR, which has both funding and temporal limitations. Thus, quite importantly, OTA, when applied with ESIC, can be an important and new paradigm for DOE programs that want to fast track the commercialization of key technologies that are created in partnership with R&D partners, by taking advantage of serial entrepreneur expertise that ESIC brings to the table.

Appendix H: A Brief Survey of EIR Programs in Practice

The Re-emergence of EIR Programs: While it is true that some of the specifics of an Entrepreneur-in-Residence (EIR) program vary – where the EIR is recruited from, how much an EIR receives in compensation, the core competencies of the EIR, and contract length - EIRs as a concept have been accepted as a contributor to VCs for nearly 20 years. EIRs, also known as "Executives-in-Residence" or "CEOs in Residence" re-emerged largely as fallout to the failed incubators that were tailored to the rapid growth of dot coms, followed by the sudden collapse of the bubble. The streamlined EIR model is much more cost-effective, with a mentality that more encourages startups to grow up and move out. [49]

In addition**,** both the VC firm and the EIR mutually benefit from an effective EIR model. The EIR establishes a relationship between herself and the fund. Moreover, the EIR can benefit from the myriad networking opportunities the role can provide, especially considering the fact that the EIR most certainly has greater exposure and credibility while affiliated with a respected VC firm. As a result of the above, the model has gained momentum in the past five years, but the real question becomes, "Do these programs work?"

The numbers speak for themselves. VCs tend to invest in one out of every 350 deals they see (.03%). EIR program research indicates that EIR programs change the percentages to one out of two or three deals. This 30%-40% success rate suggests an improvement of 1,000 times or more, which drives a significant reduction in the screening and evaluation process costs for the VCs.[50]

The success of EIR programs is also evidenced by both the sheer number of notable VC firms that employ some form of an EIR model and the relative successes they have enjoyed as a result of these programs. Among the top VC firms that showcase the most ambitious EIR programs are: Accel Partners, Atlas Venture, Benchmark Capital, Bessemer Venture Partners, Earlybird, Mayfield, Mobius Venture Capital, and Redpoint.[51]

Other firms, though not as extensively, also work in the EIR space. This includes Sequoia, Kleiner, Perkins, Caufield and Byers (KPCB),[52] Ignition, DCM-Doll Capital, and Foundation Capital

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[49] "The Valley: Long Live the EIR." *Red Herring.* January 30, 2006.

[50] Schwarzkopf, J. *Closing the "Equity Gap" in Startup /Seed Investment for ICT Ventures (Israeli Experience)*. Case Western Reserve University. January 2006.

[51] Wilson, L. "Great Work ... What it Takes to Become an Entrepreneur in Residence, the Best Job You Can Never Apply For." *San Francisco Business Times.* August 20, 2004.

[52] Unfortunately, some firms such as KCPB do not typically publicize their EIRs, thus making it rather difficult to obtain much by way of historical information; e.g. one of KCPB's most famous EIR was Peter Neupert of Drugstore.com.

Highlights from Selected EIR Programs: Of the programs mentioned above, Benchmark has set the bar by hosting in excess of 20 EIRs. According to Wilson, these EIRs have lead to 14 "liquidity events" with more than $15 billion in market value. Noteworthy "graduates" from the Benchmark EIR program include "Mike Homer, Danny Shader and Keith Krach, who went on to found or lead Kontiki, Good Technology and Ariba respectively."

Mayfield Partners' EIR model involves the EIR actively collaborating with general partners on business plans. Grant Heidrich, general partner at Mayfield, claims that the culmination of such an effort is "less risky than responding to a nicely packaged-up deal that walks in off the street with a bright shiny team of smiling faces."[53] He hastened to add, though, that this is not a model for investing the entire fund because it is far too labor-intensive.

One of the most aggressive VC firms implementing an EIR model is Mohr Davidow. According to one of their managing partners, Jon Feiber, the firm houses between four and six EIRs annually. Feiber added that almost one third of these EIRs create new companies. Of the remainder, there is a significant track record of them working at companies already in the firm's portfolio. Feiber added that "[EIRs] have a tremendous impact on us, and I think we have a good impact on them. They get to be part of the fabric of the firm, help us look at products, and extend our networks."[54]

Notwithstanding the presence of some of the major VC players in the EIR space, a newcomer to the VC arena, Ignition, may be the most active supporter of the EIR model. Ignition is a three-year-old venture capital firm in Bellevue, WA that has seen three of its first 17 portfolio companies started by EIRs.[55] The firm is currently supporting four other EIRs

Menlo Park's DCM-Doll Capital is yet another EIR player. Essentially, their model calls for one partner to mentor the EIR, escort him or her to events, assisting in networking efforts and aiding in the evaluation pf companies and ideas. David Chao, co-founder and managing general partner has personally overseen five EIRs. He notes that "The [EIR] program is net positive. Our first million in Recourse (Technologies) was 20-X -- that's ($20 million) magnitude."[56]

Mark Saul, a general partner at Foundation Capital in Menlo Park since 1999, offers that "close to 30% to 50% of our projects start [with the involvement of an EIR]."[57] According to Mr. Saul, all three of his first-round start-up investments have stemmed from an EIR's involvement.

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[53] Santiago, W. "On the Inside Track in Venture Capital." *New York Times*. January 15, 2003.

[54] "The Valley: Long Live the EIR." *Red Herring.* January 30, 2006.

[55] Cook, J. "Venture Capital: VCs Call on Heavy Hitters for Help." *Seattle Post-Intelligencer Reporter***.** September 5, 2003.

[56] Wilson, L. "Great Work ... What it Takes to Become an Entrepreneur in Residence, the Best Job You Can Never Apply For." *San Francisco Business Times.* August 20, 2004.

[57] Santiago, W. "On the Inside Track in Venture Capital." *New York Times*. January 15, 2003.

As far as the VC is concerned, it is common for the host VC to have first right of refusal on EIR-driven deals. Irwin Federman, general partner at U.S. Venture Partners reflects, "We don't ask them to give us first dibs; it just happens that way."[58]

[58] Ibid.

Appendix I: Example Key ESIC Participants and Corresponding Responsibilities

Key ESIC Participants	Example Responsibilities
Board of Directors (BOD)	• **Selects VC's, angels, and others for Capitalization Advisory Board, and sets it up Capitalization Advisory Board (CAB)** • **Sets up Technology and Sponsor Advisory Board (TSAB)** • **Writes mission statement and gets agreement with CAB, and TSAB** • **Raises funds from Government and other Sponsors, and potential limited partners in EIR-Co's** • **Hires Fund Manager, setting compensation, and appropriate incentives** • **Develops guidelines for investment selection** • **Approves, as appropriate EIR-Co investment recommended to it** • **Approves budget and other resources for operations**
TSAB Technology and Government Advisory Board (e.g. from DOE, USDA, CO, other)	• **Assures that the ESIC meets mission for Government contributions.** • **Provides Funding to ESIC** • **Assures that agreed-to funds are available for capital call (e.g. through escrowing, Other Transaction Authority, or other)**
CAB Capitalization Advisory Board (CAB)	• **Assure that ESIC meets mission** • **Work with ESIC Manager to Identify EIR candidates, and matching technology** • **Members Potentially Support EIR salaries** • **Evaluates EIR plans for new businesses and recommends funding as appropriate to BOD - each EIR-Co have to be approved** • **Assists EIR in presenting plans to BOD.** • **Invest in portfolio EIR-Co's as appropriate** • **Identify other syndication partners**
ESIC Manager	• **Overall management and operations of the fund process, including banking, legal, space, and other support (e.g. Information Services)** • **Develops Board of Advisors (CAB, and TSAB) working with the BOD** • **Writes specification for EIRs** • **Work with CAB, and TGIAB to identify, secure EIRs** • **Hire staff, and EIRs (for 1-2 year period)** • **Assists in identifying new deal flow from universities, labs, and other** • **Puts out call for EIRs and other resources (e.g. through the Resource Network)**
EIRs	• **Define the Commercialization and Funding Path Forward including needed and accessible IP, and required key success milestones** • **Get Approval from the BOD for the plan Implement the plan** • **Arrange for, and raise additional funding and syndication from (e.g. SBIR, STTR, CRADAs, etc.)**

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
May 2007

2. REPORT TYPE
Technical Report

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Enhancing Commercial Outcomes from R&D: A Framework for a Public-Private Partnership to Increase the Yield of Federally Funded R&D Investments and Promote Economic Development

5a. CONTRACT NUMBER
DE-AC36-99-GO10337

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
L.M. Murphy; P. Jerde; L. Rutherford; and R. Barone

5d. PROJECT NUMBER
NREL/TP-110-40463

5e. TASK NUMBER
1100.1000

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

8. PERFORMING ORGANIZATION REPORT NUMBER
NREL/TP-110-40463

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)
NREL

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 Words)*
This paper explores a new model for public sector investors to enhance and accelerate the commercialization of clean energy investments.

15. SUBJECT TERMS
partnership; R&D; technology transfer

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
Unclassified	Unclassified	Unclassified	UL		**19b. TELEPHONE NUMBER** (*Include area code*)

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18