Wisconsin's Model for Commercializing Emerging Industrial Technologies

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ABSTRACT

A systematic method for commercializing emerging industrial technologies is an important, but often overlooked part of most industrial energy efficiency programs. Emerging industrial technologies, particularly process technologies, typically encounter commercialization hurdles that drastically slow or prevent them from reaching full commercial success and thereby reaching Best Practice status. The results of fewer new Best Practices are fewer energy savings produced by industrial efficiency programs, lower success rates for R&D programs, struggling technology developers and fewer improvements to industrial competitiveness.

CleanTech Partners (CTP) has developed a Mentoring and Investment Model to commercialize emerging industrial technologies. The model addresses four categories of commercialization hurdles: validation of technology performance and reliability; validation of technology's value proposition; the firm's business model viability; and the firm's financial capacity. CTP truly partners with developers by offering mentoring and investment funds to be used to overcome identified commercialization hurdles. CTP negotiates a partnership agreement that helps align the motivations of all parties toward commercializing the technology, saving energy and developing a viable new business.

CTP's model can help federal and state R&D programs increase their success rate and can also inform and advise R&D programs on the methods and criteria employed to choose which technologies to fund. Programs that promote industrial Best Practices can use the model to systematically evaluate emerging technologies and create a feeder system of validated new Best Practices. Finally, energy technology developers can use this model to assess their commercial readiness, anticipate commercialization hurdles and reach commercial success.

Introduction

Improving industrial energy efficiency through successful commercialization of emerging technologies is the ultimate goal of most federal and state programs that fund research and development (R&D) of industrial energy efficiency technologies. However, this goal has proven to be elusive and difficult to achieve.

The R&D process is fraught with failure. Typical of academic inquiry, only a fraction of research projects yield successful laboratory-scale trials. Then a fraction of successful laboratory-scale technologies complete successful pilot-scale demonstrations. Finally, a few successful pilot-scale demonstrations are successfully demonstrated at commercial-scale.

Surely a technology has a good chance of commercial success once it achieves successful commercial demonstration. Data do not show this to be true. From 1978 through 1999, the federal government spent $91.5 billion on energy R&D (DOE-1 2001). Most of the funds were spent via U.S. Department of Energy (DOE) programs. While not all the funds were spent on industrial technology R&D, a recent report (DOE-2 2001) stated that while DOE had funded R&D for several hundred industrial technologies, only 54 were considered commercialized.

CleanTech Partner's (CTP) evaluations of emerging forest products technologies further documented a disconnect between successful commercial demonstration and successful commercialization. In 2006, CTP's team evaluated 141 DOE-funded industrial technologies developed for the forest products sector. The results were startling. Only six were available for sale. Fewer than 25 percent were found by the industry evaluators to have any medium-term commercial potential. Most were evaluated as having no commercial application.

Nearly all industrial technologies, particularly industrial process technologies, encounter a "Valley of Death" on their path towards commercial success. Many do not survive the journey. The Valley of Death is a popular metaphor described in classic Diffusion of Innovation models that represents when the technology has passed the Innovators Stage but has stalled in the Early Adopters stage. California's Emerging Technologies Coordinating Council identifies this area as "The Chasm," which lies early in a technology's commercial growth phase, shortly after a few early adopters have installed it. Regardless of the name given, there is a systematic gap or flaw in the process that publicly funded R&D programs use to commercialize emerging industrial technologies.

This systematic flaw requires a systematic solution. CTP's Mentoring and Investment model's success hinges on systematically assisting developers identify, determining if and how to overcome these commercialization hurdles and preventing them from falling through the cracks in traditional R&D programs. The four categories of commercialization hurdles CTP has identified are: 1) validation of technology performance and reliability; 2) validation of technology's value proposition to target markets; 3) business model viability; and 4) financial capacity. Failure to adequately address all four categories usually results in a technology becoming a long-term or permanent Valley of Death resident.

CTP's underlying rationale is that for an emerging technology to be truly innovative and capable of achieving commercial success, it must embody a value proposition that can be proven and accepted by the target marketplace. Some innovations may have value propositions that are "ahead of their time" and may find success in the future. But for those programs or developers who are seeking near-term commercial success, an early evaluation using the rigors of capitalism can increase the odds of commercial success or save the entrepreneur much time and effort spent trying to commercialize a technology with insufficient value to the market.

About CleanTech Partners

CTP has developed a unique Mentoring and Investment model for assisting early stage companies that are trying to commercialize an emerging industrial technology. One unique feature of CTP's model is the ability to offer capital in the form of loans or equity to companies with emerging technologies that are not typically served by traditional financial institutions. This capital, coupled with CTP's technical, business and financial expertise can help identify and bridge commercialization hurdles. CTP develops a partnership agreement, and then mentors its partners along their commercialization path. CTP also helps its partners identify and apply for appropriate state and federal grants that will facilitate meeting their strategic business goals.

Partnership agreements and CTP investments are structured to align the motivations of the developer, the State public benefits program and CTP. Grants tend to create project-driven partnerships and have proven marginally successful at aligning motivations for commercialization. A true partnership occurs when all parties have "skin in the game" and each

partner's ultimate success is derived from the same outcomes. This philosophy forms the basis for CleanTech Partners' name and business model.

CTP is a nonprofit organization located in Middleton, Wisconsin that began operations in 2002 as the Center for Technology Transfer. CTP's mission is to help businesses implement emerging technologies in Wisconsin. CTP is funded primarily by Focus on Energy, Wisconsin's energy efficiency and renewable energy initiative funded via public benefits funds. CTP's work with emerging technologies is designed to transition emerging industrial technologies to the point where they can be considered Best Practices in Wisconsin.

CTP employs six professionals capable of completing comprehensive business and technical due-diligence on a wide variety of business opportunities. Staff expertise includes: entrepreneurship, commercial banking and venture investment, economic development, executive management, professional engineering, manufacturing engineering, agricultural economics and PhD's in chemistry and microbiology. In addition, four of CTP's staff has been entrepreneurs: starting, securing financing and running early stage businesses. CTP also contracts with experts with industry-specific expertise and networks.

CTP, Focus on Energy and Commercialization of Emerging Industrial Technologies

CTP's efforts to commercialize emerging technologies work in concert with Wisconsin's Focus on Energy (Focus) program, which promotes energy efficiency and renewable energy Best Practices to residential, commercial and industrial markets. CTP's role is to lead and operate a "feeder program" of new Best Practices for the Focus Industrial program. CTP and Focus work together to commercialize industrial technologies to the point where their operations are validated and energy savings can be estimated reliably. At that time Focus can provide verified information and adoption incentives to industries considering implementing the technology.

The CTP Mentoring and Investment Model

Documented industrial energy savings via commercialization of emerging technologies is the measure of CTP's ultimate success. Therefore, CTP's motivations are to identify and assist companies that have technologies that are at or near commercial readiness. Few of these firms are located in Wisconsin. In effect, CTP harvests or transfers technologies that have received R&D support from other state or federal programs and are using its model to help these companies introduce their innovation into Wisconsin markets, produce energy savings and help Wisconsin industries become more competitive. While CTP has taken long-term positions with some Wisconsin-based companies, our current priorities are to identify and help commercialize technologies that will take one to two years to produce energy savings in Wisconsin.

The steps CTP typically undertakes when developing a partnership with a developer are:

- Determine technology's fit with Focus on Energy program criteria
- Conduct a technical due diligence on the technology
- Conduct a market due diligence on the technology's value proposition to target markets
- Conduct a business due diligence on the developer/company and business plan
- Negotiate and agree upon a term sheet and place the investment
- Assist with first installations in WI – meter and verify results, develop case studies

- Ongoing business mentoring and market penetration assistance with Focus
- Document and report energy savings and investment fund results annually

Appendix A details some of the initial basic questions CTP asks when conducting initial due diligence. These questions are categorized by an analysis of mission fit along with business, technology and ownership due diligence. CTP also develops an estimate of potential energy savings in Wisconsin for the technology, based on its market potential and energy saving characteristics. This initial due diligence can be done usually in one to two weeks. If a fatal flaw is discovered, the technology is filed in CTP's archives for future reference. If the technology and business pass the initial screening, CTP begins developing a partnership agreement.

CTP's model uses many of the same principles of Angel investors and Venture Capitalists (VCs), but differs from these entities in several key areas such as:

- Undertake a technical review of the technology to validate its performance and operation, but CTP offers feedback on how to overcome gaps or weaknesses
- Review of business plans, but unlike venture capitalists, CTP offers feedback and mentoring to help prospects improve their plans, business model or technology
- Use a network of experts in various industries to validate the technology's value proposition to the target markets identified by the developer. However, CTP will assist the developer with identifying and quantifying target markets for which the technology may have a compelling value proposition
- Financing is made available to qualifying prospects. CTP can presently provide up to $350,000. However CTP structures its investments in a manner that aligns the developer's needs and motivations with CTP's. Investments may be equity, loans of varied terms and conditions, sales financing or other arrangements that help the developer commercialize the technology in Wisconsin
- An equity investor usually receives a board seat as part of the term sheet. CTP provides mentoring and market penetration assistance with loans or financing

Once CTP has officially partnered with a developer, we take the next steps to ensure the technology is commercialized such as:

- Cooperatively develop a deployment plan for Wisconsin target markets
- Assist with deployment plan implementation, such as helping find candidates for first 2-3 installs – then measure, verify, document, and disseminate results
- Link the company with local networks, utility reps and Focus on Energy field staff

Depending on the type of technology, CTP and Focus may judge that anywhere from two to ten installs are needed before the emerging technology is considered a Best Practice in Wisconsin. However, once that designation has been reached, CTP's active assistance ramps down as the developer becomes established and Focus assists prospects with case studies and financial incentives for installation. By this time, the developer should be in the position to start repaying CTP's investment, and CTP can then reuse the proceeds.

In a typical year, CTP will identify and review 100 to 120 technologies. About half of the reviewed technologies do not fit CTP's narrow mission, which is to commercialize emerging

industrial technologies with electricity or natural gas savings. CTP typically is conducting more in-depth evaluations on 20-30 technologies at any one time. With additional funding CTP anticipates we will develop three to five new partnerships in 2008.

Why CTP Developed its Mentoring and Investment Model:

CTP developed its model because we saw a gap in the support available for emerging technologies between successful demonstration and successful commercialization and a contradiction in the manner programs tried to commercialize industrial technologies. The gap occurs when most state and federal programs end their support once a technology has been demonstrated. However, for emerging industrial energy efficiency technologies, successful commercial-scale demonstration does automatically lead to commercial success.

While the reasons for this are many, they can be condensed down to the statement that most emerging technologies carry at least one major flaw through the R&D phase. The flaw(s) can usually be found in one of four areas: technical, financial, business model and/or personnel. In some cases, the flaw(s) are fatal. In other cases flaws can be corrected, provided the expertise and capital are available and the developer is willing and able to change. CTP's Mentoring and Investment model is designed to assist those developers that need and will accept assistance with overcoming their technology's commercialization flaws.

The contradiction CTP found was the use of grants by programs to encourage commercialization. CTP maintains that grants do not successfully provide or align the motivations of the developer and the program, nor do grant programs undertake the due diligence rigor needed for commercial success. In the 1800s, prizes or "pay for results" were commonly used as incentives whereas today grants or "pay for effort" are the preferred method of patronage for scientific inquiry (Hanson 1998). While the author showed that the movement from prizes to grants was predictable, he concluded that fresh consideration should be given toward more "pay for results" type arrangements.

CTP maintains that commercialization support programs are best served by using the investment model and due diligence tools of VCs, but done so in a manner that mentors young companies while rewarding for results or outcomes valued by all partners. These outcomes are typically negotiated before the investment or partnership is created. While grants can quickly develop project partnerships, which work well for R&D, investments create the business partnerships with the aligned motivations needed for commercialization.

Common Commercialization Flaws with Emerging Industrial Technologies

One of the key flaws with many emerging technologies is that they are not an innovation. While industrial energy efficiency R&D programs, universities, even industries themselves struggle to define what constitutes an innovation. CTP maintains that an innovation was best described below (Canton 2000).

> An innovation that proves its value is adopted and accepted by the marketplace or society. If a critical mass of customers is willing and able to pay for your innovation, it is a success. Innovation, by this definition, cannot exist in a vacuum. An innovative idea in the lab, or on the envelope scratchings of an inventor, is not enough. As innovative as Leonardo Davinci's sketches were, they

do not meet the definition because they were way too far ahead of their time to be executed successfully and have measurable economic impact. The rigors of capitalism – ideas, products, services, and processes judged by the marketplace – confirm the validity of what is or what is not innovative. Put simply, an innovation has value if it is blessed by customers reaching for their wallets en masse. Having said that, it worth noting that an innovation that customers are unwilling or unable to pay for today might satisfy the value component of this definition tomorrow.

While CTP's and Canton's definitions of innovation are shared closely, it is remarkable how many technically masterful developers concentrate all their time, energy and resources on technical issues as they strive to reach successful demonstration, which they see as the ultimate goal. These developers are often operating under the old axiom, "if you build a better mousetrap, the world will beat a path to your door." This may be true for mousetraps, but it certainly has not shown true for emerging industrial energy efficiency technologies. Rarely have developers that come to CTP been able clearly understand and explain their product's value proposition to their target markets (i.e. how much better or cheaper than the competition their mousetrap needs to be before industries will adopt it and which industries those will likely be.)

Much time, energy and money could be saved if more developers and the programs that support them undertook or required a serious commercialization due diligence process shortly after successful lab-scale trials. This process would allow developers time to address (or learn that they cannot address) many of the commercialization flaws CTP encounters most frequently including:

- Demonstrations were conducted without the level of metering, monitoring and unbiased third party verification that potential customers want to see. Therefore customers do not believe the technology works as advertised
- Some breakthroughs did not offer an attractive value proposition to the target market and never would no matter how much its performance was improved
- The industry that agreed to demonstrate the technology was facing unique or one-off circumstances, such as a local regulatory issue not faced by the vast majority of the industry, thereby misrepresenting the true market for the technology.
- Many technology developers were not skilled in commercializing or manufacturing their discoveries. They may be ineffective sales people, may lack business savvy and sometimes target the inappropriate market(s)
- Some developers had secure positions with good benefits, such as in universities or government labs, and had no intention of leaving to commercialize the technology, nor did they have a commercialization partner
- Technology developers wanted someone else to take most of risk
- The developer was highly leveraged and could not raise additional money to fund the gap between research and full commercialization due to commercialization flaws or the potential risks-returns did not capture interest of conventional funding sources

One of the recurring themes discovered during CTP's research of other commercialization models was that some programs had felt, in retrospect, they had failed to "kill the fatally wounded" technologies in a timely fashion. In these cases, the developer or the

technology had a fatal flaw that they were unable or unwilling to overcome, and the commercialization program did not have the will to turn off assistance. Nobody is done any favors in this arrangement. Therefore CTP designed its model to first identify the commercialization flaws, develop an agreement with milestones for overcoming these flaws, and include remedies if one or both parties fail to execute. Much like a business partnership, this allows both organizations to move on if all parties' motivations do not continue to be aligned.

Why Relying on Angels and Venture Capitalists Is Not Enough

Investments by Angels and VCs in "clean technologies" have likely never been higher than today's market. However, there are many good, practical emerging industrial technologies that can produce solid energy saving that currently cannot or will never attract Angel/VC funding. CTP may operate similarly to angels or venture funds, but we do not compete with them. If a developer can satisfy the requirements of these entities, or even banks, and has the wherewithal to commercialize in Wisconsin, CTP's assistance and funding are not needed. None of CTP's partners, at the time the partnership was established, could attract angel or venture funding, and few industrial energy efficiency emerging technologies fit the Angel/VC model because these entities usually require their investment partners to:

- Operate in large, high-growth market(s) with the ability for annual sales of $50-$100M
- Show potential valuation of $100M in 3 to 5 years
- Have all key risk areas addressed with a defined exit strategy
- Need large funding: >$3M, (very few deals <$500K)
- Operate in the year's "hot" or "in vogue" industry
- More often than not, be an ongoing concern with established product(s) and/or customers.

CTP's experience has been that many good emerging industrial technologies meet few if any of the Angel/VC criteria, particularly at the time they most need capital. Angels and VCs also do not provide feedback and mentoring to prospects that do not pass muster. As of April 2007, three of CTP's earliest partners have successfully attracted Angel and/or VC funding. But there was no support from these types of entities when the partnership agreements were first completed. While these companies have not delivered large-scale energy benefits in Wisconsin, the long-term prospects for each are good regarding energy benefits, economic development benefits and CTP receiving its investment back with a return.

Program Results

Since 2003, CTP has assessed over 600 emerging technologies and has developed commercialization partnerships with ten developers of emerging industrial technologies. For State of Wisconsin fiscal year 2006 (July 1, 2005 to June 30, 2006) verified 10-year annual energy savings were 752 megawatt hours and 846,000 therms. The 2006 program benefit-cost ratio was 6.5/1. The 2007 benefit-cost ratio is expected to be 18/1. As of April 2007, CTP had committed its entire $3.5 million investment fund to ten emerging technology partnerships and five financings of stalled Best Practice projects. The Best Practice projects are short-term financings that allow CTP to put some of its funds to use achieving immediate energy savings

while we work to develop new partnerships with emerging technology developers. Table 1 provides a list and summary of each CTP emerging technology partnership and Table 2 shows stalled Best Practice financings.

Table 1. List of CleanTech Partners Emerging Technology Partnerships

Company/$$	Technology Description	Status/Energy Savings
Wisconsin Fiber Resources - 2003 $100K	Low-energy fiber repulping technology for plastic coated paper.	Company closed. CTP recouped $60K.
Bioionix, Inc. – 2004 $63K loan	Disinfect waste water with ultra high frequency electricity to create hydrogen peroxide.	Loan repaid. Capital formation completed 06; potential of 640,000 kWh/yr or 12,000 therms/yr.
Virent Energy - 2004 $100K – loan & equity	Hydrogen production technology using carbohydrate feedstocks. Paired with fuel cell for demonstration	Current on loan payments Markets TBD, capital raised, 44,000 kWh/yr one time install.
Thermochem Recovery, Inc. – 2004 - $220K loan/equity	Biomass gasification and steam reforming to increase BTU value	Negotiating first application in WI 200 million kWh/yr per application
Lucigen: C5-6 – 2005 $350K equity	Enzymes that increase ethanol production at ethanol plants	Raising capital, product rollout soon 900,000 kWh/yr & 400,000 therms/yr potential at 6 WI sites
Spinworks - 2005 $350K revenue-linked loan	Ceramic tube insert for fuel gas/air mixing, retrofits into heat treat furnaces	Repaying loan 15 installs, 570,000 therms/yr reduced to date, 1.3 million therms/yr potential remaining
Paprican – 2006 $350K vendor financing	Computer modeling based on direct measurement to improve biomass and recovery boiler efficiency and reduce emissions	Negotiating first application in WI 400,000 therms/yr displaced with renewable (single project)
Energy Concepts – 2007 - $350K vendor financing	"Thermosorber" a gas-fired heat pump supplies air conditioning or refrigeration at the cold end and uses the reject heat to heat hot water	Executing deployment plan 260,000 kWh/yr + 125,000 therms/yr, 20 apps. in WI
Furness Newburge – 2007 - $350K vendor financing	"Advanced Oxidation" used by metal casters to reduce scrap rates, mold-bond materials, and VOC emissions.	Executing deployment plan 1,000,000 kWh/yr and 5,000 therms/yr per application, 20 applications in WI
Intelliburn - 2007 $350K vendor financing	Natural gas boiler control system that trims and improves boiler swing load efficiency.	Developing deployment plan 250,000 therms/yr per application, 20 applications in WI

Earlier CTP partnerships were channeled toward long-term commercialization partners whereas investments over the past two years have focused on technologies that could produce energy savings within a one- to two-year timeframe. Of the ten partnerships CTP has established, the partnerships are rated as (based on energy savings and return of capital): one success, one Loss, eight to be determined. The one unqualified success is CTP's partnership with Spinworks is detailed below. The one loss was CTP's first partnership, a $100,000 investment in Wisconsin Fiber Resources. This plastic-coated scrap paper recycling technology failed for business reasons, but CTP recouped $60,000 of its investment.

Table 2. CTP's Financing of Stalled Best Practices Projects

Company/$$	Technology Description	Status/Energy Savings
Madison Kipp Corporation – 2007 $350K loan	Installation of a stack-melting furnace, which uses furnace flue gases to preheat the metal for melting.	Installation in late 2007 70,000 therms/yr
Muscoda Protein Products – 2006 $350K sub-debt	Biomass boiler replaced natural gas boiler for cheese and whey processing	Installed 2006, loan balance prepaid 4/07 590,000 therms/yr
Flambeau River Paper – 2006 Loan $350K	A suite of quick-payback energy savings projects	Current on payments 2.7 million therms/yr & 1.9 million kWh/yr
Wisco Hotel Group 2006 Lease - $130K	GREM (Guest Room Energy Management) uses a system of sensors to control HVAC in unoccupied hotel/motel rooms	Current on payments 5,000 therms/yr & 700,000 kWh/yr
Showcase Kitchens 2005 Loan $41K	Energy Efficient Spray Booths for painting	Current on payments 14,000 therms/yr & 37,000 kWh/yr

In the past, CTP has also used its funds to provide loans for six stalled Best Practice technologies. These loans were used for large energy saving projects with good paybacks which the industry could not pull together adequate financing to make the projects meet internal hurdle rates. Reasons for these companies' inability to get financing from traditional sources (CTP does not compete with banks or other institutions) included:

- Lenders unwillingness to offer amounts or terms that meet borrower's return on equity need
- Existing loan covenants preventing the borrower from borrowing more money,
- Borrowers that were fully leveraged
- Borrowers that had just funded a capital expansion project and had not budgeted for a large energy efficiency improvement project as part of the expansion

Example of Long-Term Partnership: Lucigen Corporation

In 2004, Lucigen Corporation of Middleton, Wisconsin was a molecular biology company with technologies capable of rapidly cloning new gene expressions from a single cell. A small part of their R&D focused on developing enzymes that could unlock additional starch from corn at the high temperatures used in fermentation, which would enable increased output from corn ethanol plants with no increase in corn throughput and little increase in energy use.

In April 2004, Lucigen was awarded a NIST grant to conduct further research on these enzymes. But being a startup and short of capital, Lucigen did not have funds required to match the NIST grant nor were they concentrating on this business opportunity since it was considered outside their core business. CTP conducted its due diligence and partnered with Lucigen, providing $250,000 in the form of an equity investment designated for use as match to the NIST grant. Since that time, Lucigen has developed CornBuster™ which improves bioethanol production by nine to12 percent with minimal new energy inputs. This production increase can mean about $3-$5M of additional income per plant/year. Lab-scale trials were completed for two Wisconsin ethanol plants in 2006.

In August 2006, Lucigen spun off its ethanol enzyme business in creating C5-6 Technologies, on which CTP retained a seat on the Board of Directors. The first commercial trial is expected in 2007 and energy savings should begin accruing in 2008. In September 2006, C5-6 won a $1.2M DOE grant to develop SoyBuster™ to convert cellulose in soymeal to ethanol.

Example of Near-Term Partnership: Spinworks

CTP initially identified Spinworks as an investment candidate at NREL's "Industry Growth Forum" in November 2004. Founded in 2001, Spinworks is located in Erie, Pennsylvania. 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, but 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, Pennsylvania or New York (the initial providers of research funding). Spinworks had made no sales calls in Wisconsin, despite the state's #10 industry rank for heat treating and two of the four company founders were Wisconsin natives.

Spinworks was a small company with solid, but developing 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, and with no independent verification of the technology or the vendor, Wisconsin firms were unlikely to try Spyrocors and put their processes at risk.

After extensive due diligence, CTP elected to partner with Spinworks and provide a $350,000 revenue-linked financing for Spinworks to hire a sales representative focusing on Wisconsin, and to help Spinworks expand its business and product offerings. The first two installations were metered and performance was verfied by Focus. As of June 30, 2006, 15 Wisconsin furnaces were converted with more planned. CTP booked energy savings for 2006 at about 570,000 therms, and Spinworks began making payments to CTP.

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 percent, with six to twelve month paybacks. The first ever HeatCor installations (2) occurred in Wisconsin in September 2006.

Lessons Learned

The lessons learned by CTP in operating a unique emerging industrial technology commercialization program have been many. However, since early 2006 CTP has honed and solidified its approach to identifying potential partners, conducting due diligence and constructing and finalizing partnership agreements. Key lessons learned include:

- Successful demonstration does not equal commercial success
- Promotion of unvalidated emerging technologies hurts all programs in a portfolio. Accepting vendor claims or single case studies is not adequate due diligence. Often the information provided is not valid and in other cases, the vendor does not know the answer to important questions
- A program will find it very difficult to conduct due diligence on an emerging technology once a potential customer is involved
- Nearly all emerging technologies have flaws even after one or two successful demonstrations
- In reality, successful commercialization always takes longer and is more difficult than expected
- Be prepared to screen lots of technologies to find each good commercialization candidate
- Links with top decision-makers in industry and their networks are crucial to commercializing industrial emerging technologies
- Coordination with a Best Practice program like Focus or utility programs is crucial for sustaining commercialization momentum
- Buyers need to quickly understand how emerging technologies work (no black boxes), and benefits need to be described to they are immediately apparent
- Industries buy based on trust & relationships:
    - An emerging technology is real to industry when someone trusted is using it nearby (~100 mi.)
    - Trusted third party verification of demonstrations are crucial, and too rare
    - Demonstrations of one-off applications are of low value and too common
- Technologies with a value proposition based on solving a problem are much easier to commercialize than those offering an opportunity to improve efficiency
- Emerging technologies often have effects on production and the social structure in industries
- The easiest emerging industrial technologies to commercialize are installed easily and can be bypassed easily. Technologies that affect industrial processes are viewed as huge risks by industry, no matter how bullet proof they are
- Presenting a full range of purchasing and service options to prospective buyers speeds commercial success. Too many developers present only "you can do this yourself" options versus "I will do this for you" options
- A mentoring and investment model can be controversial and difficult to understand for funders who are used to traditional demand-side programs.
    - All program partners involved need to agree up front and be consistent on program measures of success from year to year
    - A program that seeks to increase the supply of new Best Practices rather than increase the demand for Best Practices confounds funders and evaluators
    - There will be fewer projects, a higher percent of program funds will be used to administer the program, but there are fewer losses and investment funds return to be used again
    - Investments create business partnerships whereas grants create project partnerships
    - Business partnerships bring decision leverage and align motivations of all parties: Success = multiple sales, profits and energy savings

Finally, the methods and lessons from CTP's commercialization efforts can help inform and guide R&D programs as they design solicitations and choose which technologies to support. Having a better understanding of an emerging technology's, or the developer's, commercial prospects can help R&D programs make more effective use of their scarce resources. In addition, CTP's model could be leveraged by other states cost-effectively to support the commercialization of emerging technologies in their states. CTP has a unique, experienced team in place and could help states set up their own commercialization efforts designed to help companies bridge the Valley of Death.

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Appendix A

CTP Initial Technology Commercialization Viability Screening

Example Commercialization Viability Criteria	
CTP Mission Fit Analysis: Does Tech fit with Focus on Energy's mandated mission & goals?	Does technology offer industrial electricity, natural gas, or propane savings, or produce on-site renewable kwh or therms as mandated under statutes governing Focus on Energy?
	Are the potential energy savings or renewable energy production in WI of a magnitude and probability that CTP's investment of time and funds will yield an acceptable B/C ratio? (See Energy Impact Analysis below)
	Is it an emerging technology (fewer than 2-10 installations in WI)?
	Is the company interested in doing business in WI?
	Is CTP mentoring and funding critical to successful commercialization in WI?
General Business Analysis: Will business model lead to tech's commercial success, multiple installs in WI, and documented energy savings or renewable energy production?	Is there a company formed to commercialize the technology?
	Has an adequate business plan been completed?
	Does the tech and service offer a timely, compelling value proposition(s) to an identified target market in WI?
	Do WI target market(s) find the claimed value proposition(s) compelling enough to induce action?
	Is the value proposition a markedly better, cheaper or faster alternative to competitors (the status quo and known competitors under development)?
	Does the company compare favorably with competitors regarding time to market, distribution channels, sales, service, or warranty?
	Can multiple sales opportunities be realistically expected? (large one-off applications may also be of interest)
	Does tech. developer have sufficient capital, assets, earnings and liquidity to become a successful business?
Initial Technology Analysis: Can tech perform in reliable & valid manner and deliver on proposed value proposition?	Are the technology's fundamental operations valid according to accepted scientific principles?
	Can the tech developer explain the science of the tech's operations in a manner acceptable to target market(s)? (Black box techs are very difficult to commercialize.)
	Have sufficient performance validations (successful demonstrations, third-party verified results) been produced for each proposed value proposition?
	Has a realistic COGS been completed and compared with competitors or other alternatives to solve the similar problem/opportunity?
	Can the tech, in its present design, deliver on the claimed value proposition(s)?
	Is the tech's development timeline realistic?
	Is key intellectual property protected and free of disputes?
	Is the tech designed to offer a solution to an industry recognized problem? (Opportunity-driven techs are more difficult to commercialize.)
Management Analysis Can Management deliver tech to commercial viability?	Does the management team have sufficient experience, skills and understanding of the market to execute the business plan?
	Is the team capable of raising the necessary capital to complete commercialization?
	Does all management personnel pass background checks and/or can they adequately explain previous business deals that were less than successful?
	Are these the type of people with which CTP can negotiate a fair partnership agreement and successfully work together?

Initial CTP Energy Impact Analysis

Category	Claimed Target Market #1	Claimed Target Market #2	Claimed Target Market #3
Describe Proposed Value Proposition			
Estimated Energy Potential			