New Strategic Partnerships: Building Bridges over the "Valley of Death"

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ABSTRACT

New partnership programs are evolving in California to help overcome commercialization barriers to new energy efficient or peak demand responsive technologies. By optimizing coordination among technical R&D, manufacturers, utility programs, and other actors such as installers and users, public goods R&D organizations can provide the structure to bridge new energy efficient technologies across the "valley of death" between the lab and the marketplace.

The California Public Utilities Commission's (CPUC) ambitious targets for sustained energy efficiency and peak electric demand reductions will require a consistent flow of new technologies, systems, guides and tools to meet customer needs and these aggressive goals. With the over $2 billion approved for energy efficiency deployment programs statewide for 2006-2008 there will be a significant increase in needs for more advanced technologies. These are actually national and global needs, since other states and the Federal government are also increasingly active in similar efforts to minimize wasted energy.

This paper illustrates lessons learned from recent efforts to coordinate and optimize California R&D and deployment programs in building energy efficiency. These programs include coordinating development of R&D products with demonstration partnerships with University of California (UC) and California State University (CSU) campuses and with providing a "pipeline" of new technologies to the campus programs and the broader market. These efforts involve university centers, manufacturers, business analysts, and major energy users, and feed directly into utility incentive programs. Strategically linking these programs provides models that will help new technologies be targeted to successfully bridge the gap into the marketplace.

Summary

This paper describes some efforts of the California Energy Commission's Public Interest Research and Development (PIER) program and its partners to overcome barriers and move deserving R&D products into the market. In particular, we review the current PIER collaboration with the energy managers of the University of California (UC) and California State University (CSU) systems as "real world laboratory" partners in testing and demonstrating PIER products. This PIER-UC/CSU partnership model acts as a catalyst to leverage successful PIER technologies into statewide use on university campuses and provides valuable feedback for improving PIER R&D. Illustrating the PIER partnership approach could have broad implications for other energy, sustainability and green buildings programs. The paper also briefly describes several other PIER initiatives to help evolve the public sector R&D process toward larger and earlier deployments and real reductions in energy use and peak demand.

Background

Buildings use the biggest share of the nation's energy use (EIA, 2006). Buildings, and in particular the commercial sector, have increased their total energy use more than any other sectors over the past 50 years.

Table 1.

Sector	*Energy Use, Quads (10^{15}BTU)*	*Percent*	*50-Yr Growth*
Residential	21.2	21.3%	307%
Commercial	17.5	17.6%	463%
Industrial	33.2	33.3%	183%
Transportation	27.8	27.8%	306%
Totals	99.7	100%	

Buildings also wreak havoc on the power supply infrastructure: Peak demands are high, with huge time-of-day, day-of-week, and seasonal variations. There are very large opportunities for energy and peak demand savings although estimates of these quantities vary among researchers (cf. Nadel et al, 2004).

Private industry is producing many helpful energy efficiency innovations. However, this is limited by a marketplace tendency to provide inadequate incentives for those entrepreneurs to serve public goods such as air quality, energy resource conservation, and environmental sustainability. Public sector R&D programs play a crucial role in focusing on advancing those broad public goods and reducing risk to encourage private industry's competitive involvement in product improvement, variations, and production.

Large amounts of public funds are being dedicated to development and deployment of energy efficiency innovations for buildings—notably in California and New York - but also by Federal government agencies, national laboratories, and an increasing number of other states. The rationale of those public efforts is to complement and encourage the private market by focusing primarily on the public good of energy efficiency rather than only on private advantages in market factors such as economy, convenience, and productivity. The programs also serve to increase the private benefit to the company developing the technology through reduced economic risk, increased profits, increased access to market to get to increased profits.

Most energy efficiency *deployment* activities utilize conventional technologies and practices rather than more effective best-practice innovations. This is due to short-term payback considerations and natural risk reduction tendencies as well as lack of knowledge. New technologies carry risks including inadequate performance, high prices, unpredictability of support needs and availability, and unexpected user dissatisfaction. New energy efficiency innovations must overcome these barriers in order to get into the market. The "valley of death" or "chasm" (e.g., Moore 1992-2002) represents the difficulties of the passage of innovations from the lab to the market. Too many good R&D products stall at this step due to a lack of effective market connection. The result is that despite many opportunities—and R&D successes—in public sector R&D innovations in energy efficiency, predictable barriers in manufacturing and marketing can prevent market acceptance and adoption. Experience shows that in most cases if you *only* build it, they will not come.

UC/CSU/IOU Energy Efficiency Partnership Program

College and university campuses define a key market for energy efficiency technologies, with extensive building space on each campus under unified management. Many campus buildings are outmoded, despite continuous expansion through new construction and remodeling. Multi-campus systems provide even greater opportunities to serve as effective commercial and institutional market leaders through cross-campus and systemwide collaborations.

As a part of the state's broad-based effort to reduce energy consumption and peak-period power supply demands, in 2003 the California Public Utilities Commission authorized public-goods funding for a statewide multi-year UC/CSU/IOU Partnership Program (the Partnership) to increase energy efficiency throughout the state's two higher education systems in collaboration with the state's investor owned utilities (Partnership, 2006). These two systems comprise 33 campuses across California, representing a combined 160 million square feet, a broad range of buildings with varied energy use per building and a high energy usage overall, and many opportunities for improvement. In 2006-2008 a similar program has been created for the state's network of 105 two-year community colleges with approximately 55 million square feet.

California Public Goods Charge funds of $12 million were allocated to the Partnership in 2004-05, and an additional $45 million was assigned to the program for 2006-2008. This Partnership program will improve the energy efficiency of California college campuses by:

1. Implementing energy efficiency retrofits
2. Facility retro- and continuous commissioning, including extensive permanent energy monitoring at the building and subsystem level (Monitoring Based Commissioning--MBCx)
3. Energy efficient education and best practices development and training.

The investor owned utilities provide program-wide coordination, technical information, and assistance as needed. Each campus has its own separate but coordinated program, with its own budget and priorities. All campus energy efficiency implementation projects within the program are selected locally. Most projects are conventional, using already commercially available technology improvements in lighting, space conditioning, and controls to maximize cost-effective energy savings. But to be most effective in helping to meet the 10-year California PUC energy and peak electric demand savings goals as well as the Partnership's own campuses program savings targets will require a "pipeline" of even more efficient new technologies and systems. Consequently, the CEC's PIER-Buildings program provided a variety of recent new energy-saving products and funding support for pilot testing to prove the effectiveness of those products in the campuses program, expand their use on campuses, and accelerate their production and competitive position for the broader commercial market.

The PIER Energy Efficient UC/CSU Campuses Program: Collaborations on Innovative Technologies

Goals and Organization

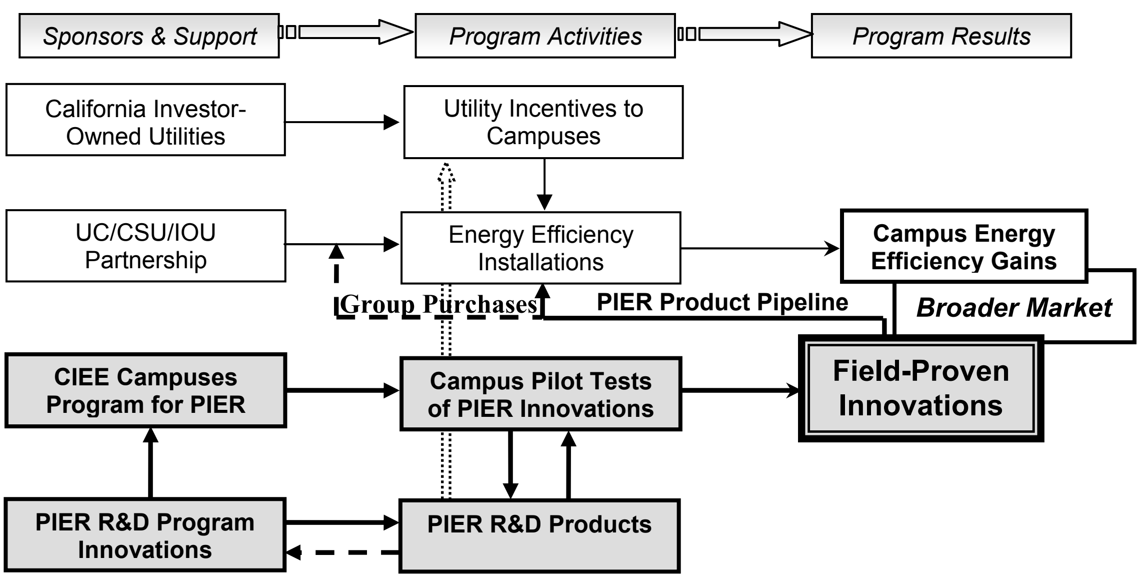
To complement the Partnership program, the PIER Energy Efficient UC/CSU Campuses Program's emphasis is focused on establishing RD&D test-beds and early adoption of PIER technology innovations. The 2004-2007 PIER program provided $3 million for the following goals:

- Accelerate the adoption of advanced technologies and practices by the California university and college campus sector, and use this sector as an exemplar for other California educational and institutional sectors.
- Advance current PIER research through the development of a public building research and demonstration test bed.
- Develop and participate in a partnership between the PIER program and a CPUC-awarded energy efficiency program to meet California's public interest energy efficiency objectives.

The overall objectives of the PIER program are the introduction of new technologies into the campuses, providing a strategic partnership for R&D pilot tests and to validate technologies for wider use in the campuses Partnership program. This arrangement provides significant administrative and technical assessment cost savings for PIER demonstrations since the campuses have professional energy managers who have helped with the identification of field pilot sites, implementation and evaluation of these technologies. This collaboration could save as much as 10% of the total cost of the demonstration program.

The PIER innovation-transfer portion of the UC/CSU campuses program is shown in the shaded portions of the logic flowchart below. As the diagram indicates, the successful pilot tests of specific PIER innovations lead to broader use of those technologies in the campus energy efficiency upgrading.

Figure 1. CPUC/CEC/Utility Program



Systemwide collaboration is the major factor influencing the program's effectiveness, providing powerful economies of scale for producers of innovative products and services. The co-ordination of these partnerships provides both a new model for bridging the "valley of death" and for catalyzing faster adoption of efficient technologies by the 33 campuses. Some of the key advantages of this collaboration between the R&D and implementation programs are:

- Reduces PIER RD&D costs through more economical securing of field test sites, with long-term energy efficiency goals and ongoing collaborative opportunities, while helping the campuses to meet or exceed the CEC Title 24 energy code requirements.
- Improves PIER products and provides a “pipeline” of new energy efficient products to the Partnership program, other utility programs, and other markets.
- Leverages expertise of university centers, e.g. the California Lighting Technology Center (CLTC) and improves the field and customer knowledge of the centers to apply to their R&D projects.
- Accelerates the adoption of technologies by the campuses and helps them meet their Sustainability and Green Building goals over extended periods of collaboration.
- Campus demonstrations and multi-campus bulk purchasing enable early orders and production volume, encouraging manufacturer investments and cost reductions.
- The combined Partners and PIER program models can also be applied to fit the community colleges and other potential long-term field testing and implementation campus-type institutions such as educational, state, institutional, bio-technology, high technology, and healthcare facilities.

A potential drawback of the use of campuses for such demonstrations is the possibility of program delays due to collegiate bureaucracies, although in this study the campus partners were highly responsive. Another possible problem is that links to the broader commercial market could be weak due to the unique aspects of college facilities and needs. However, such educational facilities represent a major market in themselves, and the manufacturers involved make those broader market connections routinely.

Innovation Acceleration Process: The Bi-Level Light Fixture Example

A key function of the PIER campuses program is to accelerate the market introduction of key recent PIER-funded energy efficiency products. This involves the use of pilot testing, assessment, and feedback to encourage the original product developer-partners as well as competitors to produce, market, build volume, and reduce the cost of the PIER products. The CIEE campuses program’s scale and coordinated decision making made it an ideal opportunity for this kind of market acceleration as a part of the R&D function’s practical responsibilities to assure its own cost-effectiveness.

Figure 2. Bi-Level Stairway

The bi-level stairwell fixture provides one example of PIER's approach to accelerating commercialization of its innovations. The bi-level fixture is designed to enable a major reduction in stairwell energy use by reducing light levels when the stairwell is unoccupied. Fire safety codes require that stairwells be lighted at all hours, but occupancy may be as low as 5% of the time. 24-hour full-intensity lighting was once considered necessary, but the bi-level fixture eliminates the unneeded energy use, still assures safe and rapid exit from buildings in emergencies, and meets latest codes. Potential energy savings nationwide from reducing the excess lighting (when no one is in the stairwell) are estimated at approximately 25GWh/year, with peak demand savings in the 300-400MW range.

The bi-level fixture, developed by NYSERDA in conjunction with LaMar Lighting, improves effectiveness of earlier concepts at reduced cost. The bi-level fixtures use occupancy sensors to provide ample light when a stairwell section is occupied and a reduced but still usable lighting level when no occupancy is detected. The bi-level fixtures replace all the conventional always-on fluorescent fixtures at each stairwell landing, reducing light levels cost-effectively in unoccupied periods to typically 10 to 30 % of full egress illumination levels. If the sensing and control system fails, the higher lighting level is automatically selected.

In the Partnership project, the bi-level fixture was pilot tested in 8 buildings on 8 campuses involving over 200 fixtures. Results were dramatic: Great overall performance and campus acceptance as well as 63% energy savings replacing T12 fixtures versus only 20% savings retrofitting the existing stairwell fixtures with T8 lamps and electronic ballasts (CEC 2006).

Following the pilot evaluation, a major step now in progress is the assembly of a multi-campus group purchase initiative estimated at 2,000 to 4,000 units. This group buy allows the manufacturer to move quickly to more efficient high-volume production, allowing a large price reduction due to economies of scale.

This step also permits further broader diffusion of this technology beyond the campus setting. Both manufacturers and program sponsors are now publicizing this innovation's successful large-scale adoptions as well as seeking further large deployments by commercial building developers and managers.

The result of this strategy is that mass production capacity will be deployed much earlier than could have occurred without this campus initiative, largely successful as a result of the

Partnership. The price is also being reduced significantly, highly effective marketing content is being developed from the campus experience, and widespread awareness is being generated among commercial and institutional building managers as well as ESCOs.

Other New Technologies Involved

The PIER campus energy efficiency innovation pilot program also includes a variety of other recently developed lighting and HVAC technologies with PIER support. Examples include the following application-ready innovations, with further details available via web (CIEE, 2006):

- Energy efficient downlighting system
- Integrated classroom lighting system
- Smart bathroom light switch/nightlight
- Variable speed control for food service exhaust hood fans
- VAV system static pressure reset strategy
- Load Shed ballast and control system

The multi-building/multi-campus program scope has provided a broad range of opportunities for campus energy managers to gain firsthand experience with effective new technologies and share information among all campuses. Campus case study evaluations have been completed for most of the innovations, and results are now being shared among all campuses and the industry at large. Further campus strategic procurements are anticipated for energy efficient products. These pilot tests, group purchases, and broader applications on campuses are leading the initial manufacturers and potential competitors to gain confidence in technologies and prepare for broader commercial introductions. There is also great potential to build existing public and campus-based centers for energy, technology, sustainability and green building into this model of new partnership programs.

Implications for Broader Application

The UC/CSU Energy Efficient Campuses program provides an opportunity for continuing PIER collaboration in the introduction of new technologies. The program has been successful in creating interest and momentum for PIER's new technologies among the campus energy managers, and they have shown interest in further joint work with PIER on future innovations.

This is a promising model for broader use elsewhere with other technology innovations and campus-type institutions as market-opening collaborations. Other R&D agencies in other states may find nearby state college systems to be effective demonstration and market-opening partners for innovations that would otherwise have difficulty in achieving early market visibility. That visibility, together with initial campus orders for the initial production units, can make the difference in a manufacturer's resolve to invest scarce resources in commercialization.

Other Recent PIER Market Connection Initiatives

Other PIER technology development efforts have produced similar partnership models for expediting commercialization of energy efficiency innovations, encouraging "crossing the chasm" into production and fostering commercial competition through open technical information sharing. This section presents several further examples.

Collaborations with utilities. Utilities are ideally positioned to accelerate deployment of energy-saving innovations, through their due diligence responsibilities for assuring effectiveness before committing to use of ratepayer funds for incentive payments to adopters of a new technology. Utilities can be especially important to public-goods funded R&D organizations such as California's PIER program, national labs, and university research programs, which have no direct manufacturing or deployment capabilities.

For example, California's PIER program works closely with the state's major electric and gas utilities through the Emerging Technologies Coordinating Council (ETCC). This effort is backed both by the PIER R&D coordination as well as the separate state-mandated Emerging Technologies programs established by the utilities to review and affirm the effectiveness of new energy efficient technologies before their use in incentive programs.

Among other functions, the ETCC seeks to assure that PIER is aware of market needs for new products and that the utilities and PIER programs share in planning and conducting proof-of-concept and field demonstrations to meet both R&D and utility needs both quickly and cost-effectively. Formal responsibilities at this interface may be assigned to either PIER or a utility, depending on the project and its needs, but both participate.

Utilities may also be involved in a form of the consortium approach. For example, the commercial air conditioner manufacturing industry has historically been reluctant to develop and produce units optimized for energy efficiency in the nation's widely varying regional climate zones, justifiably fearing a loss of cost competitiveness by diluting their mass production volumes. California's PIER program sought to overcome that barrier through a current PIER project to develop and demonstrate the value and cost-effectiveness of air conditioners optimized for the West's hot and dry climates (SCE 2006).

Laboratory prototypes were successfully developed and tested, and nine major utilities both in California and throughout the hot/dry western states agreed to field test, evaluate, and consider incentives for the technology among their customers, thus lowering the market risk to manufacturers. In addition to providing a broad base of performance data, the demonstration of such broad utility support for this innovation helped to encourage several major HVAC manufacturers to produce market-ready production units for the summer 2006 field tests and make early commitments to their production and marketing, generally contingent on proof of performance and business case.

R&D and business case integration. Too often a technological development runs into unexplored and unexpected business-related barriers to commercialization. In this section we explore an example of avoiding this danger through partnering with manufacturers in development of the technical and business aspects of an energy efficiency innovation. In the hot-dry air conditioner project, the PIER research team was able to interest potential manufacturers by developing a preliminary business case for climate-optimized air conditioners in lieu of a uniform nationwide product. That business case included projected performance analysis, assessment of market size and nature, distributor and installer acceptance studies, utility interest in providing purchase incentives, and estimation of production costs, pricing, and energy savings versus the latest standard SEER 13 and higher conventional units.

A key aspect of that business case was the R&D team's realization that manufacturers would expect to do their own optimization rather than simply adopt the researchers' prototype designs—particularly since the lab-test prototypes were for proof of concept rather than optimized for production. Individual manufacturers have extensive product-development capabilities and would naturally want to employ their own preferred solutions. Consequently the main technical product of the PIER project was a technical performance specification for manufacturers to meet. Then the project provided product credibility by supporting independent lab and field testing of the manufacturers' proposed units in the summer of 2006 (ongoing).

This business case analysis also included the discovery that HVAC manufacturers already produce near-optional combinations of components (condenser units, evaporator coil choices, air handler/furnace options, etc.) that could approximate the hot-dry performance specification but were not so identified or documented for the education of distributors and installers. This discovery raised the possibility of meeting the hot-dry market need most economically by identifying the appropriate combinations in the manufacturers' product catalogs and educating distributors and installers on how to specify them properly. If successful, no new units would have to be designed or produced. The result of this strategy was that after the project's successful development of high-performance prototypes that proved the concept, this attention to manufacturers' business issues produced a comprehensive and practical R&D strategy that resulted in demonstration-phase unit production agreements with several major HVAC manufacturers. The multi-state field demonstration results for those units, to be available in the fall of 2006, will determine the likelihood of broader market entry.

Business-oriented public-private R&D collaborations. PIER's 2001-04 Lighting Research Program was a major effort to accelerate the development and deployment of innovations in commercial and residential lighting technology. That $5 million R&D program employed a variety of technical teams from private lighting manufacturers, national labs and other research organizations to make simultaneous advances in many different topics ranging from ballasts and sensors to LEDs, fluorescent fixtures, controls, and integrated single-package lighting systems (AEC, 2004).

The Lighting Research Program employed an independent team of Market Connection specialists to assess market and business-related issues of all the technologies under development. That team developed a standard business case content outline usable for all the R&D projects and helped the technical teams to use that template to understand the practical business issues that each of their products had to meet. Business cases were shared with manufacturers both within the program and through outreach to others.

The Market Connection team also prepared an independent evaluation of each product's performance, cost, and likelihood of commercialization as well as recommendations for further product refinement. That assessment also involved California utilities in analyzing how the program's most advanced products would fare under their due diligence requirements for incentives and other utility support.

This integrated approach resulted in increased production investment confidence of several manufacturers, accelerating production in some cases and increasing likelihood of production in others. This approach also served as an R&D management tool enabling the early assessment of the cost/benefits and the market acceptance of the project. This early evaluation was used to stop projects and redefine others which led to better optimization of the R&D

investments. Finally, it led to early consideration of several of the R&D products in the utility Emerging Technologies review process.

Conclusions

- This paper provided several examples of integrating technical and business elements within public goods energy efficiency R&D programs, including business case development in parallel with technology, the use of R&D collaborations with manufacturers, cooperative R&D and utility efforts, and early-adopter consortia for initial sales volume acceleration.
- There are particularly strong opportunities for *long term* strategic collaboration with higher education facilities, government facilities, other public institutions, and multi-site or campus-type organizations which have long-term goals and commitments to energy efficiency, reducing R&D field test costs while providing those organizations with early first-hand access to valuable innovations.
- With a properly comprehensive technical/business orientation and industry partnerships, as shown in these strategic models, public goods R&D can be very effective in moving products from lab to marketplace and competitive market development.
- Effective short-term energy efficiency and demand response R&D must be understood to inherently include both technical and business elements to assure that the technology meets the requirements of the marketplace. This includes the needs of all key value chain actors such as distributors, installers, and utilities as well as end users.
- Research organizations can employ a variety of models and strategies as illustrated in this paper for integrating technical and business considerations into the public goods R&D process.

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