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LIGHTING RESEARCH PROGRAM PROJECT 6.1 PROGRAM-WIDE MARKET CONNECTION SYSTEM

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This report is dedicated to the memory of Don Aumann,

the California Energy Commission's

Lighting Research Program Project Manager from 2002–2005.

Don was the consummate engineer, dedicated to energy efficiency and his work. Most important, he was a wonderful family man and friend. He will be missed.

Don Aumann

June 17, 1959 – March 9, 2007

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Preface

The California Energy Commission's Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program conducts public interest research, development, and demonstration (RD&D) projects to benefit California.

The PIER Program strives to conduct the most promising public interest energy research by partnering with RD&D entities, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy Innovations Small Grants
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Transportation

Lighting Research Program Project 6.1 Program-Wide Market Connection System is one of three final reports for the Market Connections Element of the PIER Lighting Research Program (contract number 500-01-041). This project was conducted by Bevilacqua Knight, Inc., and managed by Architectural Energy Corporation. This report is an appendix to the final report for the PIER Lighting Research Program conducted by Architectural Energy Corporation. The information from this project contributes to PIER's Building End-Use Energy Efficiency program.

For more information about the PIER Program, please visit the Energy Commission's website at www.energy.ca.gov/pier or contact the Energy Commission at 916-654-5164.

Table of Contents

Preface i

Abstract iii

Executive Summary……...vii

1.0 Introduction..... 1

1.1. Program-Wide Market Connection Rationale..... 1

1.2. Project Goal and Objectives 1

1.3. Report Organization 2

2.0 Project Approach 3

2.1. Overview of the Tasks 3

2.2. LRP Market Connection Framework..... 3

2.3. Background: R&D and Market Connection 5

3.0 Outcomes I: R&D Product Marketability Guidance..... 9

3.1. Centralizing the Market Connection Process 9

3.2. Segmenting Projects According to Market Readiness 10

3.3. Market Connection Activities for Near Market-Ready Projects..... 11

3.4. MC Activities for Other R&D Products 13

3.5. Additional Activities on Behalf of All Products 16

4.0 Outcomes II: Alliance Building 23

4.1. The Key Alliance Partner Concept..... 23

4.2. Screening Criteria Used to Select Key Alliance Partners..... 23

4.3. California Utilities as Key Alliance Partners 27

4.4. Interactions with Other Important Organizations 28

4.5. Conclusions 28

5.0 Outcomes III: Media and Outreach 31

5.1. Overall Outreach Strategy 31

5.2. Broad Outreach Activities and Results 33

6.0 Conclusions and Recommendations..... 37

6.1. Conclusions 37

6.2. Recommendations..... 40

6.3. Benefits to California 41

7.0 References..... 43

8.0 Glossary 45
Appendix A: Guide to working with the Market Connection Element
Appendix B: Product Development/Market Connection Chart
Appendix C: Technology Transfer Template
Appendix D: Sample Press Release
Appendix E: Product Summary Sheet

List of Figures

Figure 1. The three key aspects of the MC project, here compared to the three legs of a stool, provide strategic support to meet the projects goals. 4

List of Tables

Table 1. Market connection requirements for key stages of product development 5
Table 2. Market connection requirements for key stages of product development 11
Table 3. Summary of CPUC tests 20
Table 4: LRP audiences 32

Abstract

This report is an appendix to the final report developed under the Lighting Research Program, which supported the creation of new lighting technologies and products that can save energy, cut peak demand, and reduce air pollution for the residents of California. It comprised 15 research projects conducted in four major research areas and three market connection projects and encompassed both residential and commercial sectors, as well as outdoor lighting associated with buildings.

This report presents a summary of the activities, results, and conclusions of a two-year project to improve the market focus, business cases, and industry support of the Lighting Research Program's Research and Development projects. Those activities included development of commercialization (technology transfer) plans, creation and use of industry alliances to promote the Lighting Research Program products, implementing an industry awareness campaign of materials and events, and fostering personal interactions with utilities and other key actors in the value chain for effective market entry. These activities were intended to accelerate the commercial introduction and viability of the energy efficient lighting products developing under the Lighting Research Program.

Keywords: Technology transfer, technology transfer plan template, commercialization planning, commercially viable energy efficient lighting products, industry awareness campaign, industry alliance, outreach, Lighting Research Program

Executive Summary

Background

All too often, technology development proceeds before market needs and realities have been assessed. In these cases, the resulting product or prototype may never reach the market or intended user - and any potential benefits are lost. The Lighting Research Program, which included numerous projects to develop energy efficient lighting technologies, took steps to avoid that fate by creating a market connection element.

Objective

The Program-Wide Market Connection System project directed and coordinated the market activities of all the Lighting Research Program development projects to enhance and accelerate the commercial introduction and viability of the Lighting Research Program products.

Goals

- Create, implement, and evaluate an innovative, coordinated, and intensive method of fulfilling the technology transfer requirements of the Energy Commission's Public Interest Energy Research Program.
- Provide expert guidance to the program manager and technology developers on the product specifications and economics needed to maximize market success.
- Build alliances with key institutional intermediaries, including efficiency advocacy groups, energy professional and trade associations, utilities, and governmental regulatory authorities.
- Provide consistent and appropriate information in effective media to relevant market actors and consumers to increase understanding and acceptance of all Lighting Research Program products.
- Provide developers of selected Lighting Research Program products with expert guidance on accelerating products toward effective market preparation and entry.

Outcomes

Several valuable outcomes resulted from the market connections activities:

- **An in-depth technology transfer plan template was developed for market and economic product evaluations.** This template provided consistency across the entire program. It outlined the main technology transfer activities needed to help manufacturers and other key actors understand the views of the product developers. These templates provide an overview of each product's development status, markets, and business case. They also recommend specific actions to encourage the product's production and successful market introduction in California.

- **Key Lighting Research Program products were identified for extensive demonstration and market readiness activities.** The market connection team grouped technologies according to two main stages in the development cycle: 1) those ready for demonstration and near market-readiness and 2) those in the early stage of product development. Projects in the demonstration and near market readiness group were chosen for more intensive market connection support. These projects included the bathroom nightlight, the bi-level stairwell fixture, and the integrated classroom lighting system.
- **Valuable input was received from Virtual Panel sessions.** The market connection team periodically hosted informal Virtual Panel sessions to collect information from various industry representatives and probe specific issues. The input was documented and shared with the project leads and other Lighting Research Program participants.
- **Six products were reviewed using the California Public Utility Commission Total Resource Cost test.** The market connection team reviewed the major products involved in the program and evaluated these products through the lens of the California Public Utility Commission's *Energy Efficiency Policy Manual*.
- **Key Alliance Partnerships were developed and seen as beneficial.** A number of influential organizations accepted the invitation to become Key Alliance Partners of the Lighting Research Program. The market connection team selected organizations deemed to be gatekeepers to their members and particularly influential in determining the professional and market acceptance of new lighting technologies.
- **The market connection team collaborated with utilities and spread the word about the Lighting Research Program products through presentations, workshops, and demonstrations.** Coordination with utilities is a central goal for the Lighting Research Program since in California, the four main investor-owned utilities and many municipal utilities serve as a direct conduit to customers for new technologies through utility incentive programs.
- **Various materials were developed for outreach activities, and outreach activities reached multiple audiences.** The market connection team organized outreach activities for several key conferences, including the American Council for Energy Efficient Economy Summer Study 2004, Light Fair 2004, and the Illuminating Engineering Society of North America California Chapters. These activities focused on end-users, utilities, lighting specifiers, and other manufacturers and researchers. Most of the materials developed are available at www.archenergy.com/lrp.

Conclusions

Overall, the market connection team demonstrated the value of integrating market introduction planning with research and development from the earliest stages. The integrated market/research and development focus inserted guidance from manufacturers and other industry players into the early research and development process, which allowed researchers to adapt research and development plans toward creating products better

aligned with market needs. Further, the interest and participation of these partners were keys to delivering information on the Lighting Research Program and its products to a wide audience, potentially accelerating the pace of manufacturing and introduction of market-ready products.

Recommendations

The Energy Commission should consider integrating market connection activities with research and development efforts in other projects. Although it is difficult to quantify near-term benefits of this strategy, the potential long-term value seems significant. Other specific recommendations follow:

- Use the technology transfer plan template as a benchmark for future projects.
- Keep the market connection team independent of the technical team. The role of the market connection team should be to define business cases and build market momentum.
- Dedicate an appropriate amount of funds to direct market connection efforts.
- Extend market connection efforts beyond the timeframe of the research and development elements.
- Involve utilities earlier in all energy efficient product-oriented research and development projects, especially in the design and responsibility for field tests and product descriptive media (brochures).

Benefits to California

Statewide benefits from the activities accomplished under the market connection projects are the expected acceleration of the acceptance and adoption of the Lighting Research Program technologies and products. Market penetration estimates for the California marketplace have been set at one percent for all the Lighting Research Program projects. However, some products may see up to five percent market penetration due to the quality of economic analysis and code and standards research, market tools developed, and outreach activities completed under the individual research and market connection projects.

1.0 Introduction

The California Energy Commission's PIER Lighting Research Program (LRP) was a $5.2 million R&D program focused on developing and introducing new energy efficient lighting technologies into the marketplace. This unique program, which ran from 2002–2005, was funded by the Energy Commission and managed by Architectural Energy Corporation (AEC)

The LRP included 15 research projects and spanned both the residential and commercial sectors, as well as outdoor lighting associated with buildings. The goal of the LRP was to create new lighting technology and products that would: save energy, reduce peak demand, and reduce pollution for the citizens of California. This current report is the final summary of accomplishments from Project 6.1, the *Program-Wide Market Connection System.*

1.1. Program-Wide Market Connection Rationale

Too often research and development (R&D) projects succeed technically but fail to reach the market or to find commercial success. The LRP provided an innovative centralized approach to improving the market focus of its development activities, thereby increasing the ultimate commercial viability of LRP's technology products.

The market connection (MC) project enhanced the technology transfer activities within each of LRP's development projects by:

- Providing each project with consistent product assessment and commercialization recommendations from key lighting market experts
- Assisting and advising the developers of the most market-ready products in the transition from R&D to market entry
- Providing a consistent set of product description materials for use in industry reference and public education by the Energy Commission, individual product developers, and other market actors

One highlight of the MC project work was the development of technology transfer plans (TTPs) for LRP's technology products. The TTPs provide an integrated marketing packet with consistently branded brochures, which help LRP promote all its products through coordinated promotion at major lighting and energy efficiency-related events.

1.2. Project Goal and Objectives

The overarching goal of the MC project was to improve the market focus of all the LRP R&D projects, thereby increasing their ultimate commercial viability. The enumerated objectives of this project were to:

- Create, implement, and evaluate a new coordinated and intensive method of fulfilling the technology transfer requirements of the PIER Program.

- Provide specific expert guidance to the Program manager and technology developers on practical product specifications and economics needed to maximize market success.
- Build alliances with key institutional intermediaries including efficiency advocacy groups, energy professional and trade associations, and governmental regulatory authorities at all levels.
- Provide consistent and appropriate information in effective media forms to relevant market actors and consumers to enable understanding and acceptance of all Program products.
- Provide developers of selected earliest Program products with expert guidance on accelerating products toward effective market preparation and entry.

The MC project, led by Bevilacqua Knight, Inc. (BKi), addressed all these core objectives.

1.2.1. Meeting PIER Program Goals

The PIER Program is organized to meet a set of programmatic goals established in its enabling legislation. The LRP's market connection element met the PIER goal of "Improving the Energy Cost/Value of California's Electricity" by decreasing commercialization risks and accelerating the market entry of the Program's technology products. This in turn should lead to their increased use and help obtain the real-world energy savings that the products have the technical potential to achieve.

Likewise, this project met the secondary PIER goal of "Improving the Environmental and Public Health Costs/Risk of California's Electricity" by increasing and accelerating the successful market entry of the Program's energy-saving products. This, in turn, should lead to reduced electricity use and its attendant environmental impacts.

1.3. Report Organization

This report is organized as follows:

- Section 1.0 Introduction provides the background and rationale that led the Energy Commission to include a program-wide market connection system in the Lighting Research Project.
- Section 2.0 Project Approach section explains how these broad goals were divided into actual tasks for the MC team and how these tasks were integrated with the work done by each development team.
- The following three sections discuss in detail three different outcomes for the MC project in three distinct areas: product marketability guidance, alliance building, and media and outreach.
- Section 6.0 Conclusions and Recommendations provides a summary of this project's results and lessons learned.

The Appendices provide a variety of materials with additional details to support the summaries in the report text.

2.0 Project Approach

2.1. Overview of the Tasks

This final report provides an overview of the following main tasks performed under the MC project to meet the objectives described in the previous section.

- **Task 1. All-Products Marketability Guidance:** This task sought to improve the ultimate marketability and value of all technologies developed through the LRP by soliciting early feedback on potentially valuable product refinements and development goals that would increase the likelihood of key commercialization steps, such as production commitments and financing, timing acceleration, market introduction, product placement and support, and consumer acceptance.
- **Task 2. Commercialization Alliance Building:** This task sought to strengthen and create, as needed, informal alliances and partnerships with influential groups in the commercial adoption and use of energy efficient lighting technologies.
- **Task 3. Early Products Commercialization Support:** The goal of this task was to accelerate the market entry of the key lighting products most likely to be ready for commercialization during the course of this program.
- **Task 4. Product Outreach and Media Development:** The goal of this task was to provide key audiences with the information they need on the full range of Energy Commission lighting R&D programs, products, and potential benefits, using new informational materials and direct outreach through conferences, workshops, and key-individual contacts.
- **Task 5. Technology Transfer Activities:** The goal of this task was to provide a reusable blueprint for managing the technology transfer process and then work with the project managers to help implement the technology transfer plan.

The MC project also played a key role in helping to structure and conduct the periodic program-wide review sessions with the Program Advisory Committee (PAC), and organized and conducted further reviews with its own Technical Advisory Group (TAG) and subsets referred to as "virtual panels" for specific issues.

2.2. LRP Market Connection Framework

The overall approach of the Market Connection effort was organized around three critical concepts that framed the project's objectives into a more strategic form. These concepts are shown in Figure 1 and discussed in the subsections below.

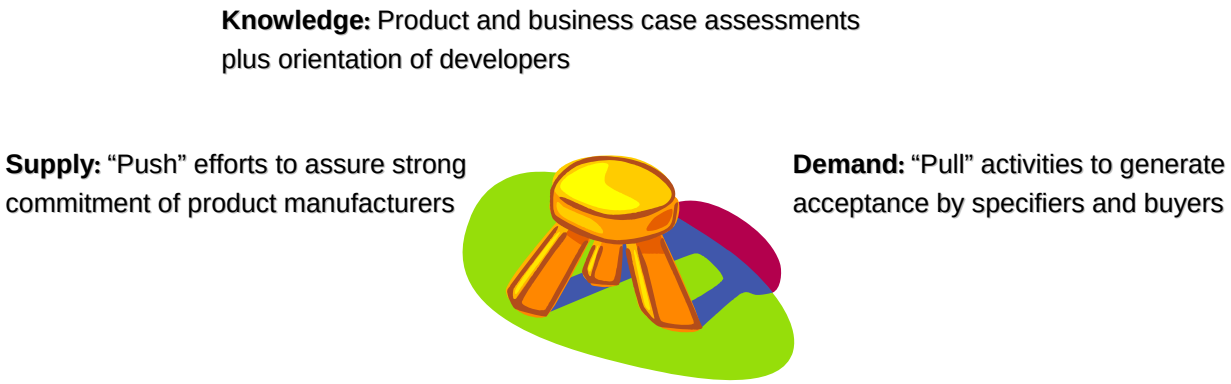

Figure 1. The three key aspects of the MC project, here compared to the three legs of a stool, provide strategic support to meet the projects goals.

2.2.1. Knowledge

The **knowledge** component of the strategy was essential during the early stages of product development to ensure that all assumptions concerning the market were well tested and integrated into the feature list of the new product.

Work involved assessing and understanding the LRP products and business cases and providing feedback into product design and funding. Activities in this area centered on developing a standard TTP template and content and applying the template to each LRP project to create crucial early product assessments and broaden the perspectives of the product developers.

2.2.2. Supply

The **supply** component was relevant to the middle stages of development when it may be feasible to leverage aspects of a potential manufacturer's existing development cycle to achieve cost savings unanticipated in the laboratory.

Work involved "push" efforts to strengthen the connections of products to manufacturers and to assure the continuing and increasing commitment of those manufacturers by strengthening business cases, improving communication, and building relationships. For example, work on the CFL downlight and light-emitting diode (LED) outdoor luminaire projects led developers to adapt product designs to the manufacturer's requirements, improving likelihood of their products going to market.

2.2.3. Demand

The third or **demand** component of the project's strategy was relevant later in the development process, when there was an actual product to market. Work involved "pull" activities to educate specifiers, buyers, and users in the advantages of the LRP products, including outreach efforts, as well as work to identify and counter market barriers, such as restrictive codes, lack of design tools, and risk perception. These activities were designed to

mitigate the dangers of over-promising a new product before it is market-ready—or even of testing a product in too wide-scale a demonstration before it is ready for that level of scrutiny.

2.3. Background: R&D and Market Connection

The MC team developed a Product Development/Market Connection flow chart (see Appendix B) as a guide to show when different market connection materials would be needed to meet the R&D team's requirements at different stages of each product's development. The typical stages in an R&D program are:

- Planning
- Concept development
- System level design
- Prototyping
- Testing and validation
- Product ramp-up

Success for a specific R&D product requires close integration with market-focused research, analysis, and outreach appropriate to each of these stages. The MC project designed its activities to complement each critical stage of product development, as shown in Table 1 and discussed in the subsections below.

Table 1. Market connection requirements for key stages of product development

Development Stage	Market Connection Requirements
Planning	Conduct market research (by feature) Analyze market viability
Concept Development	Analysis economics Benchmark versus competitive products
System Level Design	Find/assist manufacturing partners Adjust design (if necessary) to support ease of manufacturing Create technology transfer plan
Prototyping	Assess marketability, consulting with industry experts Develop basic communications materials (web page, information sheet, etc.)
Testing and Validation	Conduct outreach activities (press releases, product samples, media kit, presentations at conference, etc.)
Product Ramp-up	Work with utility programs to broaden application of technology Analyze performance to date

2.3.1. Planning

In the planning stage, a development team usually has a particular concept, such as LED-based exterior lighting, but the practical application of that concept may be relatively undeveloped. For example, the exact way in which an LED will be integrated into exterior lighting might not be known. A market-related deliverable at this stage would involve basic market research to assess whether there will be a viable market willing to purchase the technology and whether these people are likely to be responsive to energy efficiency as a feature of the product.

At this point, suggestions may be made for ways to integrate relevant secondary characteristics that might improve the success of the product or to distinguish a particular sub-segment of the market that might react more positively to the technology. This level of market analysis should occur as part of the proposal for a product idea's inclusion in a large development program such as the LRP. This suggests that some funding might be used in the planning process to evaluate proposed concepts by doing independent, preliminary assessments of technical and market viability.

2.3.2. Concept Development

During concept development, early sketches, models, and renderings are developed, and the original idea advances in dialogue with the estimated expectations of the market. For example, the development team for the LED outdoor luminaire went through a number of different approaches. The team first considered two colors of LEDs, blue and amber, to create white light and full illumination; the blue LEDs would be illuminated only when the motion sensor was activated and the amber LEDs would function as a standby light. The team realized that this design would be cost-prohibitive and eventually settled on a small number of amber LEDs as the standby light and a standard incandescent or CFL for the brief moments of full illumination.

The MC team sought to provide or guide a preliminary economic analysis based on cost estimates for production of a finished version of this design. As part of this analysis, it is important to benchmark potential competitive products to guide further refinements to the product and determine the importance of efficiency gains versus other possible improvements compared to what is currently on the market.

2.3.3. System Level Design

At this design stage, when the developers are at the point of creating early stage prototypes, the MC team worked on finding or assisting manufacturing partners. In the kitchen downlight project, for example, close communication with the manufacturer at this stage allowed the researchers to change the design to gain benefits from the manufacturing processes and components already in use by the manufacturer. This greatly reduced the cost of the product and made the energy savings more significant. As part of the process of securing a manufacturing partner, any preliminary market research should be extended to a complete TTP. The MC team developed the content scope for such plans in the LRP---it can be seen in Appendix C.

2.3.4. Prototyping

As product development moved through the alpha, beta, and final prototype stages, the MC team gathered opinion from the larger community of professionals in the field. In the LRP, this was accomplished by holding "virtual panels" of industry experts and doing marketability assessments where needed. Materials such as web pages or an information sheet can often help to inform the research and implementation communities on the emerging product.

A preliminary press release can also be written to begin publicizing the product to specifiers and end-users. However, too much publicity and optimistic forecasts earlier in the development cycle are usually costly to the ultimate success of the product if the product is later delayed and initial market expectations are not fulfilled. In the LRP, the varying product development schedules often required most publicity to be deferred until near the end of the program.

2.3.5. Testing and Validation

Coincident with the testing and validation stage, which includes demonstrations and small volume production, as well as minor product improvements, the most substantial outreach about the product is usually best done by the MC team. A further review of the technology by industry expects could be used to confirm how effectively the initial evaluations were integrated into the product. A production development plan is typically developed detailing the process for moving the product from small volume production to high volume. A final spec sheet should be prepared, and press releases on the test installation, product brochures, and product samples should be produced to distribute at events and conferences.

2.3.6. Product Ramp-Up

At the product ramp-up stage, the role of the MC team is to encourage the manufacturer as much as possible, considering the limitations inherent in a public-sector organization constrained from private product promotion. The LRP often had to negotiate a balance between what was acceptable advocacy for a valuable energy efficiency solution versus unacceptable LRP promotion of a particular commercial producer's unique product.

Close integration with relevant utility programs and including utilities early in the R&D process in an explicit way helps to accelerate the transfer of new technologies into the incentive programs. The involvement of utilities at this stage can also result in ideas for broader applications or variants of the original concept, increasing the market and providing more opportunities for the concept to benefit from the utility incentive programs.

3.0 Outcomes I: R&D Product Marketability Guidance

Marketability is an amorphous term, blending concepts such as practicality, economy, affordability, durability, attractiveness, profitability, competitiveness, and saturation. Defining the reasons why a product succeeds or fails once it has already entered the market is a difficult task. For the LRP, the MC team needed to be able to evaluate products while still in development and anticipate what these failures might be, just as potential manufacturers would do in their own product development processes.

To optimize the marketability of LRP products, the market connection project focused on the following activities for each LRP technology:

- Identifying the target market segment (or segments), its needs, and the choices currently available.
- Determining how success within the target market segment might be improved by changes in product design, research to better define the market, or changes in codes or standards to overcome obstacles to adoption.

3.1. Centralizing the Market Connection Process

In the past, a key issue faced by PIER programs was that innovative technologies that succeeded technically often failed to reach the market with similar success. In an attempt to correct this problem, the LRP centralized as much of the market connection process as possible and thereby has increased the viability of the technologies under development in the program.

To a large extent, the MC project acted as the central market connection function for the LRP, which undertook two important steps towards accomplishing this centralization:

- A comprehensive inventory survey
- Developing a generic TTP template

3.1.1. Inventory Questionnaire

The first PAC meeting in February 2003 was designed as a forum to brainstorm a broad market connection strategy among the program participants and industry representations. Valuable input from participants at this meeting resulted in a clear statement to the program participants of reaching the market with as many products as possible. An early outline of market connection issues and challenges educated the LRP's R&D project leads on the broad perspective on market awareness needed when developing their projects.

Towards this end, an inventory questionnaire was created and disseminated to the project leads to help frame their thinking on market issues and extract the background necessary for focusing the work of the MC team. Results informed the development of TTP templates and the analysis of each technology product's marketing needs.

3.1.2. Technology Transfer Plans

Responses to the questionnaires revealed significant opportunities for benefit through coordination of centralized market connection activities with technical R&D from project inception. Because most projects needed further guidance on technology transfer planning, the MC project developed a TTP, with all content issues identified and fully formatted as a report template.

This template outlined the main types of tech transfer activities needed to capture the current views of the product developers for the consideration of manufacturers and other key actors. The intent was to encourage the developers across the program to think through the process and to develop a full vision of their products' necessary paths to the market.

The TTP template was reviewed by the Energy Commission, AEC, and the R&D participants. The template was adopted as the experimental prototype for the LRP, with possible future extension to other PIER programs.

Drafting Technology Transfer Plans for LRP Projects

The MC project worked with LRP project leads to draft a TTP for each of the LRP technology and protocol products. BKi and AEC reviewed the TTPs and made suggestions for possible changes considering the results of their analysis.

These reports provided an overview of each product's development status, markets, and business case. Most important, they identified specific actions recommended to encourage the product's production and successful market introduction in California.

The MC team emphasized the importance of project leads thinking broadly about their product's benefits. From the end-user perspective, sometimes the key determinants of value had little or nothing to do with energy efficiency. For instance, some users may value an LRP product for its environmental image-building properties (e.g., a hotel chain seeking to "look green"), worker safety, productivity enhancement, or status as an innovator.

The team also explained that not every product needed to have a detailed economic justification. Some LRP products are only components of larger products or systems yet to be developed, and, in some cases, the ultimate consumer products may not even be known yet. In such cases, only the most general economic case is possible—but the attempt should be made, including clearly identified assumptions for the unknowns.

3.2. Segmenting Projects According to Market Readiness

Based on results of the inventory questionnaire and a review of project work statements, the MC project grouped technologies according to their stage in the development cycle, as shown in Table 2. The projects that belonged to the later phases—demonstration and near market readiness—were chosen for more intensive market connection support.

Other projects received assistance appropriate to their stage of market readiness.

Table 2. Market connection requirements for key stages of product development

Development Stage	LRP Technology Project
Demonstration and Near Market Readiness	Motion Sensor Nightlight for Hotels (Project 4.1) Bi-level Stairwell Fixture (Project 5.1) Classroom Lighting System (Project 4.5)
Early Stage Projects	LED Outdoor Luminaire (Project 2.1) LED Task Lamp (Project 2.2) LED Low Profile Fixture (Project 2.3) Retrofit Office Control system (Project 3.1) Load-Shed Ballast (Project 3.2) Improved Classroom Photosensor (Project 3.3) ENERGY STAR Lamps (Project 4.2) Retrofit Downlight (Project 4.3) Berkeley Lamp II (Project 4.4) Portable Office Lighting System (Project 4.4) Outdoor Low Glare Luminaire (Project 5.3) DALI (Project 5.4)

3.3. Market Connection Activities for Near Market-Ready Projects

3.3.1. Project 4.1a: Motion Sensor Night Light for Hotels

Overview

The Watt Stopper's Motion Sensor Nightlight is an LED occupancy sensor that can be installed in a half hour or less. It serves the dual purpose of lighting control and night lighting for hotel bathrooms. PIER-funded demonstrations included one at the Sacramento Doubletree Hotel, where the nightlight provided a 46% savings in energy usage and received positive comments from hotel guests. Due to the advanced stage of the development of the Motion Sensor Nightlight at the beginning of the program, it was considered a good candidate to serve as the template for analysis of other technologies in the project.

Market Connection Activities and Results

BKi provided detailed analysis of the economics and market data for the Project 4.1, the Motion Sensor Nightlight. Based on this analysis, a matrix was developed and included in the TTP for determining which market segments have the best chance of adopting this technology based on current pricing. In addition, it now seems clear that a number of hotel

owners will be willing to adopt this product for its environmental and convenience features even in those cases when it has a longer payback. This research has also helped determine what additional data, if known, might help clarify the size and potential of the different segments of the hotel market. The MC team has been in continuous contact with both the project lead and the manufacturer for this project to help fit new data into the analysis as they became available and to work on a strategy for making use of these data.

3.3.2. Project 5.1: Bi-level Stairwell Fixture

Overview

LaMar Lighting's Bi-level Stairwell Fixture has an integrated occupancy sensor and saves energy by operating most of the time at a low standby light level. This product is designed for infrequently used stairwells in particular but also public restrooms and other areas required by code to have minimal but constant lighting over long periods of time. The bi-level product had been released in New York, but inclusion in the PIER program opened the opportunity to test, improve, and support the bi-level concept in California. Results from subsequent LRP field tests in California indicated energy savings of 50 to 80 percent for stairwell lighting.

Market Connection Activities and Results

BKi provided a detailed analysis of the economics for each product type contained under Project 5.1, the Bi-level Stairwell Fixture. As with the motion sensor nightlight, this research resulted in the development of a matrix for determining which conditions a potential office building must meet in order for the installation of the bi-level stairwell fixture to make economic sense. This also help determined what kinds of incentives might be necessary and an ideal price point for reaching viability in a broader group of office buildings.

3.3.3. Project 4.5: Classroom Lighting System

Overview

Finelite’s Integrated Classroom Lighting System (ICLS) is a lighting system with a single manufacturer's warranty that simplifies the requisition process for schools trying to meet high energy performance standards. It provided direct-indirect fixtures, occupancy and daylight sensors, and plug-and-play interconnection cables. With the ICLS, schools receive premium lighting and controls for less than the cost of standard 2x4 troffer fixtures. Nineteen demonstration classrooms have shown energy savings of 30–50%. Although initially not as far along in development as the Motion Sensor Nightlight and the Bi-level fixture, the ICLS sufficiently advanced to benefit from focused market connection assistance.

Some other products, notably the pin-based ENERGY STAR residential fixtures, moved close to this category by the end of the LRP but could not be supported to the same degree at that late stage.

Market Connection Activities and Results

BKi completed extensive market analysis for project 4.5 and provided the results directly to the manufacturer, Finelite. Market research focused on public K–12 schools, junior colleges, colleges, and universities. Cursory data were collected on other schools, such as business,

technical, or trade schools. This research included collecting data on the process of school construction and modernization for California public schools (especially dealing with the Collaborative of High Performance Schools and the California State Architect's Office) to determine the best point in the process for introducing ICLS.

The MC team also facilitated conversations between Finelite and the Pacific Gas and Electric Company (PG&E) School Resources program to encourage consideration of ICLS for various school districts in the PG&E territory.

3.4. MC Activities for Other R&D Products

3.4.1. Project 2.1: LED Outdoor Luminaire

The LED outdoor luminaire product team had a number of ideas for trying to bring LED lights with an integrated occupancy sensor to exterior applications. The MC team met with the project team early in the process to review these ideas in their nascent form. Once the team decided to produce an incandescent/LED hybrid, it was agreed that the most natural first step would be to try and integrate it into an existing fixture rather than develop an independent mechanism that would need to be either attached to the wall (which was considered unattractive) or buried beneath the exterior siding of the building (which was considered cost-prohibitive).

The MC team's overarching recommendation was to work directly with a manufacturer to develop a demonstration model. This strategy would allow researchers to concentrate on their expertise and delegate design issues to the manufacturer. The CLTC then developed a relationship with Shaper Lighting to convert an existing line of compact fluorescent lamps (CFL) lights to the Hybrid-LED model.

Interactions with various utilities (thought to be one possible initial pathway for the technology) revealed that acceptance of an incandescent-based lighting system might pose a problem. As part of the TTP, BKi worked with the project team to show how the combination of incandescent and LED technology made the lamps more cost-effective, since significant usage savings were realized from the occupancy sensor thus eliminating the usual shortcoming of an incandescent bulb.

Nevertheless, it was still recommended that the Hybrid-LED fixtures deemphasize the incandescent lamp and consider models that used CFLs despite the fact that they were less cost-competitive, since the decade long utility investment in CFL technology was likely to serve as a barrier to their acceptance of the technology.

3.4.2. Project 2.3: LED Low Profile Fixture

The project team working on the low profile fixture research team and selected two key markets for their technology: jewelry store cases and elevators. Both possibilities provided an interesting challenge for evaluating the marketability of the final products. With elevators, it was expected that significant savings would come from the ability of elevator manufacturers to develop a smaller elevator, thus saving on steel costs. Any energy savings therefore would

be secondary to the material savings in construction. For jewelry cases, the unique ability of light emitted by LEDs to showcase the merchandise were the primary selling point.

This project provided a good opportunity for evaluating the impact of secondary (from the perspective of the LRP) characteristics in motivating a shift to energy efficient technologies. Such non-energy considerations are usually relevant when the technology being replaced has some aesthetic role or if collateral savings from changing to more efficient lighting technologies are greater than the energy savings alone.

The MC team agreed with the development team that the jewelry case project should highlight the unique characteristics of LEDs in making certain jewels more attractive. Although the savings from steel in the construction of smaller elevator cages would significantly impact the cost of elevators adopting the existing technology, there are other low-profile solutions to elevator lighting. A more extensive comparison of competitive alternatives to the LED low profile fixtures for the elevator market was recommended but not completed by the MC team. BKi also put the low-profile fixture on display at the American Council for an Energy-Efficient Economy (ACEEE) summer session in August 2004 and collected feedback from attendees and passed it on to the project lead.

3.4.3. Project 3.1: Retrofit Office Lighting Control System

The MC team worked with project lead Francis Rubinstein of LBNL regarding potential market connection activities for a retrofit office lighting control system. BKi also talked with a number of companies at the national LightFair conference (2004 Atlanta) regarding the history of activity in the office lighting control market and their successes and failures in dealing with personal integrated lighting control systems. Numerous attempts have been undertaken to bring increased control to office lighting (including DALI, another project in the LRP), and Project 3.1 was able to develop a retrofit strategy that avoided many of the costlier components of other systems.

The MC team spent significant time working on a report on the dimmable ballast market and how it would impact the relevant projects in the LRP. Conversations with the various project leads provided valuable information for researching dimmable ballasts. The MC team also researched alternative existing technologies that might compete with Projects 3.1, 3.2, and 4.4, all of which focus on office-based energy saving strategies. A brief report on these technologies was forwarded to the project leads. The common thread throughout the report was the difficulty of overcoming typical office inertia concerning issues of control.

3.4.4. Project 3.2: Load-Shed Ballast

The MC team reviewed various economic scenarios with Project 3.2, including research into alternative strategies for identifying the appropriate avoided cost model for justifying special incentives during critical peak hours. This was considered essential to the success of this project. The information was used in product discussions with Lighting Research Center, AEC, and George Loisos, the Element 3 lead. BKi also facilitated discussions between Stan Walercyzk, a respected lighting industry consultant, and the Project 3.2 team regarding his insights into possible problems with the technology. Mr. Walercyzk's insight provided a

better baseline for the installed technology and a better understanding of the ultimate possible savings in the project. Detailed research of market size and definition for inclusion was covered in the TTP.

BKi researched possible competing technologies, such as the Energy Saver/Global Commander developed by Electric City. The MC team concluded that the load-shed ballast project could not achieve success without direct utility involvement to help coordinate the implementation of a sizable enough installation base to make it a valuable source of load-shedding, considering the limited number of hours available to reduced load.

3.4.5. Project 3.3: Improved Classroom Photosensor

Two circumstances minimized the need for contributions from the MC team for this project:

- The Classroom Photosensor was being produced in-house by the project lead, who was also the manufacturer (The Watt Stopper) as an improvement on already existing product lines.
- The development cycle for the product becoming commercially available extended beyond the life of the LRP.

3.4.6. Project 4.2: ENERGY STAR® Lamps

BKi worked with the ENERGY STAR lamp manufacturers—PowerLux, American Fluorescent, Fire & Water, and MaxLite—to supply background on market size and possible entry points into the California market. BKi's efforts focused more on the smaller manufacturers, including developing a list of major lighting retail stores that might carry the new lamps when available and interviewing representatives of that outlet type.

Two of the lamps were priced in the $400–$600 range and were expected to be low volume items. The other two, priced between $50–$100, were expected to appeal to a much larger market. All four manufacturers focused first on the hotel market rather than the residential market.

BKi produced an ENERGY STAR background sheet on these products for use at trade events and hosted a phone conference with the four manufacturers to help strategize ways of contributing to the promotion of these products as they became available. Sample versions of the lamps were also exhibited at various technology events, including the national ACEEE event in August 2004.

3.4.7. Project 4.3: Kitchen Downlight

The MC team assisted extensively with the TTPs for the kitchen downlight project. That work included research on the target market to gauge its size and compilation of a list of potential competitors both in the corporate and home markets.

The marketing research for this project included lengthy conversations with other companies competing in the market to be able to gauge the appropriateness of this particular approach to solving the issues confronting CFL downlights.

Although the downlight was designed primarily for use in homes, there is a large market in commercial and office use. The MC team encouraged the developers to focus on the commercial market and performed background research on this market as well.

3.4.8. Project 4.4a: Berkeley Lamp II

In communicating about Berkeley Lamp II with LightCorp, the manufacturer of the original Berkeley Lamp, it became clear that further technical effort would be needed to move this product forward. Because of issues encountered with the original Berkeley Lamp, notably the failed ballast, LightCorp was unwilling to take an immediate risk in advancing production of the Berkeley Lamp II.

LightCorp had plans for developing five variations of the lamp—three based on the original table design and two based on a floor-standing design. However, the process of designing these lamps was costly and LightCorp had other priorities for its limited product development budget and cash flow. LightCorp determined their design research would need to be subsidized to improve the reliability and design for expanded market reach of the Berkeley Lamp II.

3.4.9. Project 4.4b: Portable Office Lighting System

The general consensus of the Virtual Panel meetings were that certain aesthetic considerations would prevent the wide-scale adoption of this technology, since moving the units around the office would create pockets of uneven light distribution. The Panel's recommendation was to either use the units primarily within single offices or to remove uplight control from the end user. The current prototype of the Portable Office System luminaire has all of the uplights controlled by a single office-wide occupancy or timing sensor and each of the downlights controlled by an individual, localized occupancy sensor. The same research into office solutions for Project 3.1 was usable by Project 4.4.

3.4.10. Project 5.4: DALI

The MC team provided market background for different technologies that would be competing with DALI. Since the DALI project was primarily a standards-based process and was well supported by the partner organizations, the role of MC team assistance was minimal.

3.5. Additional Activities on Behalf of All Products

3.5.1. Dimming Ballasts

A primary area of concern was the significance of dimming and the barrier imposed currently by the high cost of dimming ballasts. Discussion with number of different experts in the field, including companies currently specializing in dimming ballasts enabled BKi to better understand the restrictions on dimming ballast use. These restrictions are based on not only the lack of price competitiveness, but the greater inefficiency compared to instant-start ballasts.

Many possible barriers hinder the introduction of new, energy-saving dimming ballasts. In a paper entitled "Magnetic Fluorescent Ballasts: Market Data, Market Imperfections, and

Policy Success," (Koomey et al. 1995), the authors argued that the slow introduction of efficient magnetic ballasts represented "solid empirical evidence for skepticism about the effectiveness of the market mechanism in promoting cost-effective energy efficiency improvements." In this case, consumers were unwilling to purchase efficient magnetic ballasts, despite the fact that they "represented an excellent investment for 99 percent of the commercial building floor stock."

In another prominent example of market failure, Carlile Stevens and Bill Alling sued a major ballast manufacturer for attempting to protect its existing magnetic ballast business by buying and then shelving their energy-saving electronic ballast design. A thirteen-year court battle ultimately resulted in a $100 million judgment for Stevens and Alling. Amory Lovins of the Rocky Mountain Institute estimated the suppression of the high-efficiency ballast technology resulted in the loss of over $100 *billion* in present day economic benefits.

Based on these examples, BKi concluded that the ballast sector is susceptible to various kinds of costly market failure and might benefit from some kind of active intervention. The research results were presented at the September 2003 PAC meeting and prepared as a paper for publication at the 2004 ACEEE meeting. Successful market transformation in the dimming ballast market would benefit many new technologies that seek to achieve energy savings from lighting. The paper explored the nature of current barriers to the introduction of dimming ballasts, including the comparisons between the dimming ballast market penetration in the United States and non-U.S. markets, the comparative increase in component costs between dimming and non-dimming ballasts, the attraction of a low-volume business to ballast manufacturers, and the possibility that lowering dimming ballast cost might be dependent on new technological advances. A number of different possible solutions to the ballast problem were explored. The paper was not presented at ACEEE due to the time pressure of submitting it by April 2004.

3.5.2. Virtual Panels

BKi hosted a number of informal Market Connection Virtual Panel sessions over the course of the program to collect information from various industry representatives and probe specific issues. The members of the panels included Amy Cortese, Northwest Energy Efficiency Alliance; Kit Tuveson, Tuveson & Associates; James Bryan, Arden Realty; Peter Ngai, Peerless; David Malman, Architectural Lighting Design; Ron Lewis, U.S. Department of Energy (DOE); Dave Komonosky, 16500; Peter Lai, California Public Utilities Commission (CPUC); and Terry McGowan, American Lighting Association (ALA).

3.5.3. Marketability Report

In the Marketability Report, the MC team reviewed most of the major products involved in the program and evaluated these products through the lens of the California Public Utility Commission's *Energy Efficiency Policy Manual*, which defines criteria for evaluating the effectiveness of "hardware" programs funded through the Public Goods Charge (PGC). Hardware programs are those "primarily intended to provide measurable energy savings through installation of energy efficiency measures or provisions of energy efficiency

services." In the CPUC's hardware program effectiveness list, different ranks are given to different criteria[1]:

- Cost-effectiveness – 40 points
- Long-term Annual Energy Savings – 20 points
- Electric Peak Demand Savings – 15 points
- Equity – 10 points
- Ability to Overcome Market Barriers – 5 points
- Innovation – 5 points
- Coordination With Programs Run By Other Entities – 5 points

As shown, on this 100-point scale used by the CPUC, cost-effectiveness is worth 40 points. Since the LRP dealt primarily with single products in projected future programs, BKi narrowed this list to evaluate the first three categories: cost-effectiveness, long-term energy savings, and peak demand savings. These are the most tangible measures and constitute 75% of the criteria points. A discussion of these criteria follows:

Cost-Effectiveness

The CPUC's *Energy Efficiency Policy Manual* references the *California Standard Practice Manual: Economic Analysis of Demand Side Programs and Projects* (SPM) for the methodologies used to determine cost-effectiveness. In determining cost-effectiveness, the CPUC utilizes two primary measures:

- Total Resource Cost (TRC) Test – Societal Version
- Participant Test

The SPM warns that "the tests set forth in this manual are not intended to be used individually or in isolation." Although the CPUC primarily relies on the results of the TRC, which seeks to quantify the net energy cost—to society as a whole—of installing energy-saving measures, the Participant Test serves as a secondary measure of the cost-effectiveness of a program from the perspective of energy consumers. For determining the marketability of these products, both tests are relevant.

Typically, these tests have been used for judging whole programs such as utility-level incentive programs, but the SPM refrains from limiting these tests: "This manual does not specify how the cost-effectiveness test results are to be displayed or **the level at which cost-effectiveness is to be calculated** (e.g., groups of programs, individual programs, and programs elements for all or some programs)." To make the analysis of these LRP products fit better with the CPUC cost-effectiveness methodology, it is assumed each product will have a future program where some quantity (usually 5% of the assessed market size per year over two program years) will be promoted via an incentive program.

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[1] For more detailed definitions of these criteria, see the CPUC's *Energy Efficiency Policy Manual, Version 2*.

Long-Term Energy Savings

An additional, distinct goal of the CPUC is "to create permanent and verifiable energy savings over the lifecycle of the relevant energy efficiency." Long-term savings are those that last at least three years. For the LRP purposes, the total energy savings for the full life of the product were calculated.

Electric Peak Demand Savings

The TRC Test and the Participant Test calculations include variations for accounting for expected peak demand reduction. However, these rather complex formulas are based on the variable cost of electricity during different times. For simplicity, the TRC and Participant analyses for most of the LRP products use only the annual savings estimates. The exception is the load-shed ballast, which is intended for load management and not energy savings. However, use of peak demand savings has relevance as a metric. A separate number that shows the expected peak demand savings has been included without putting a price on these savings. When equipment has an on-peak load similar to the off-peak load, the effect of peak demand reduction is factored in correctly to the standard Cost-Effectiveness Tests. Equipment that saves more load at peak time than at other times will be undervalued in the TRC and Participant calculations. Equipment that saves less load at peak times than at other times will be overvalued.

Summary of Results

Different technologies were evaluated under different usage scenarios, and results are summarized in Table 3 and in the section below. To see the details of the Marketability Report, please refer to deliverable 6.1.1c-d of the Lighting Research Program (www.archenergy.com/lrp/mkt_connection/project_6_1_reports.htm).

Table 3. Summary of CPUC tests

Project Title	Scenario Description	Participant - Benefit-Cost Ratio	Total Resource Cost - Benefit-Cost Ratio	Net Energy Savings - Lifecycle – All Units (MWh)	Peak Energy Savings - All Units (MW)
2.1- Hybrid LED	Standard CFL vs. Hybrid Incandescent (New)	7.51	3.16	10,862	0
2.1- Hybrid LED	Standard CFL vs. Hybrid CFL (New)	5.16	2.20	16,586	0
2.1- Hybrid LED	Incandescent vs. Hybrid Incandescent (Retrofit)	3.18	1.22	56,648	0
2.1- Hybrid LED	Incandescent vs. Hybrid CFL (Retrofit)	3.27	1.20	62,371	0
2.3 – Elevator	LED Elevator Fixture	1.14	1.07	561	0.019
4.1a – Nightlight	Business Hotel (Remodel)	1.72	0.67	1,215	0.0395
4.1a – Nightlight	Business Hotel (Retrofit)	0.92	0.32	607	0.0197
4.1a – Nightlight	Vacation Hotel (Remodel)	3.69	1.73	3,143	0.0395
4.1a – Nightlight	Vacation Hotel (Retrofit)	1.99	0.82	1,571	0.0197
non-LRP - Downlight	(New)	9.86	5.00	18,880	0.188
4.3 – Downlight	(Remodel)	2.55	1.01	18,880	0.188
4.5 – Classroom	2-row (New)	12.21	6.11	27,405	0.645
4.5 – Classroom	2-row Dimming (New)	4.05	2.14	40,455	0.952
4.5 – Classroom	3-row (New)	1.35	0.73	26,100	0.614
4.5 – Classroom	3-row Dimming (New)	1.50	0.80	40,455	0.952
4.5 – Classroom	2-row (Retrofit)	1.34	0.57	56,767	1.336
4.5 – Classroom	2-row Dimming (Retrofit)	1.38	0.60	69,817	1.644
4.5 – Classroom	3-row (Retrofit)	0.97	0.40	55,462	1.306
4.5 – Classroom	3-row Dimming (Retrofit)	1.06	0.45	69,817	1.644
5.1 - Bi-level	2-Lamp Bi-level fixture (New)	1.94	0.95	16,057	?
5.1 - Bi-level	2-lamp Bi-level fixture (Retrofit)	2.24	1.07	27,831	?
5.1 - Bi-level	1-Lamp Bi-level fixture (New)	0.95	0.47	7,865	?
5.1 - Bi-level	1-Lamp Bi-level fixture (Retrofit)	1.29	0.59	15,433	?

- 2.1 – Hybrid LED: The hybrid LED was expected to be very cost-effective under all scenarios for both the end-user and under the Total Resource Cost test. Promotion by utilities may be limited by a single factor---no peak-related energy savings are possible since this is an exterior light. Otherwise, the product is a winner.
- 2.3 – Elevator: Under the scenario outlined in this report, the elevator low-profile downlight was cost-effective under both participant and total cost analysis. Since this product was still at a relatively early stage of development, more information would need to be uncovered about all of the associated costs and more scenarios would need to be developed.
- 4.1a – Nightlight: Under three of the four scenarios, the nightlight made sense for the end-user. However, under only one scenario did the nightlight clear the TRC test. However, since the nightlight had qualified for an existing incentive, this limitation did not really matter. The aggregate expectation for the TRC of wall switch occupancy sensors is unlikely to be impacted by sales of this specialized switch. The product was intended to be sensitive to the particular characteristics of lighting usage in hotels. However, the very positive acceptance of the nightlight from a service perspective will likely help the nightlight overcome any minor shortcomings in the Participant Test.
- 4.3 – Downlight: As with most retrofit items, the retrofit downlight was not as clear a winner as was the new construction version. However, it was nonetheless a very cost-effective energy saving solution with a huge market deserving of active promotion at every level.
- 4.5 – Classroom: A number of scenarios were analyzed using the classroom system because of the variation between different classroom layouts. While all of the layouts were cost-effective from the participant perspective, the classroom was a bit too expensive in its three row and retrofit versions from the perspective of an incentive-granting utility. Thus, a two-row version was pursued. However, different usage characteristics for the site might improve the cost-effectiveness of different versions. Also, other non-energy benefits related to client comfort and uniform light levels should be considered for the three-row system. The peak energy savings may also compensate as well.
- 5.1 - Bi-level: Because of its relatively high initial cost, the bi-level fixture was very sensitive to the characteristics of its installation location. Particular care was spent in evaluating possible locations. Three of the four scenarios tested were cost-effective, but at the periphery in retrofit situations, end users may be reluctant to purchase the bi-level unless it becoming cheaper. Also, without in-depth site information, potential users may err on the side of caution.

4.0 Outcomes II: Alliance Building

4.1. The Key Alliance Partner Concept

The successful commercialization of LRP products required the positive support of market influencers at all stages of the value chain, from the manufacturer and permitting agencies to product distributors, utilities or other public-purpose incentive providers, technical specifiers, contractors, media reviewers, building managers and owners, and the ultimate users. The LRP Market Connection effort could not expect to reach all of these effectively on behalf of each product. In addition, such efforts had to be persistent rather than end with the LRP's contract term, especially since many of the LRP products did not reach market readiness during the program. Consequently, a vital element of the MC strategy was leveraging the capabilities of key outside organizations to continue to address their value-chain constituents to support adoption of new lighting technologies.

A number of such influential organizations were solicited and 12 became LRP Key Alliance Partners. The MC team selected organizations that were seen as gatekeepers to their members, who themselves were judged by the team to be particularly influential in determining the professional and market acceptance of new lighting technologies at the different steps from lab to market. Most of the Key Alliance Partners selected were professional and trade groups, but there were some government agencies as well. Interactions with these Partners resulted in numerous publications and other opportunities to support the commercialization of products from the LRP.

4.2. Screening Criteria Used to Select Key Alliance Partners

The following criteria were used to select the list of organizations proposed to be Key Alliance Partners:

- A constituency with major influence on the adoption of new technologies, e.g., lighting designers, property managers
- Recognition as a leading member organization within its industry
- Substantial size and resources
- Professional staffs responsible for research, new technologies, member education, or media relations (contact person)
- Significant presence in California (chapters or number of members)
- Major provider of information to its constituency, e.g., via a respected conference, seminars, journal, newsletter, website, email outreach, or other educational services
- Proven or anticipated willingness to champion new lighting technologies

Not all the organizations proposed as Key Alliance Partners scored highly on all the above criteria. The organizations selected were, however, judged to the best available based on

current knowledge. There were modest additions to the list of Key Alliance Partners as the program proceeded.

4.2.1. Key Alliance Partners

The following partners were selected:

- ACEEE
- Association of Energy Engineers (AEE)
- American Institute of Architects (AIA)
- ALA
- The Association of Higher Education Facilities Officers (APPA)
- Building Owners and Managers Association (BOMA)
- DOE
- U.S. Environmental Protection Agency (EPA)
- The Illuminating Engineering Society of North America (IESNA)
- International Facility Management Association (IFMA)
- National Electrical Contractors Association (NECA)
- National Electrical Manufacturers Association (NEMA)
- Major California electric utilities, including PG&E, Southern California Edison (SCE), Sempra, and Sacramento Municipal Utility District (SMUD)

4.2.2. Interactions with Key Alliance Partners

The first step in the process was to investigate each identified organization to identify appropriate contacts. For many of these organizations, one member of the project team had ongoing contact.

The second step in building the Key Alliance Partner relationship was to provide each organization with a summary of the goals and objectives of the LRP, including an overall assessment of the benefits sought by this research program in California. In most cases, this interaction was done during a face-to-face visit.

As research products were developed, the appropriate Alliance Partner received product information, information sheets, and other material prepared as part of the overall "Market Connection" activities.

Following is a brief summary of the interactions between the project team and each of the Alliance Partners.

ACEEE

- The MC team made two visits to Steve Nadel, ACEEE director, in Washington, D.C. Mr. Nadel was fully briefed on the products coming out of the LRP and will choose publications that he deems appropriate.

- **Six papers** were presented at the ACEEE Annual Summer Meeting (Aug. 22–27,2004) by participants in the LRP, including the MC team. These were published in the meeting's Proceedings.

AEE

- **A major commitment of time** was given to this Alliance Partner by attending the AEE trade show in Atlanta, the World Energy Congress, November 17–19, 2003. Much PIER and LRP literature was distributed at this conference.
- LaMar Lighting attended the AEE West Coast Energy Management Congress and was accompanied by a member of the MC team. PIER and LRP literature was distributed.

AIA

- Interest in LRP from the AIA organization was minimal. One individual from one of the local California AIA chapters did participate as a LRP PAC member.

ALA

- In the May 2004 TAG conference call, Terry McGowan of ALA offered to help with this connection, based on the recent progress with the residential ENERGY STAR fixtures.
- Contact with Mr. McGowan laid the groundwork for the Energy Commission or the manufacturers to pursue matters with ALA once prices and production schedules were set for these fixtures.

APPA

- The editor of APPA's magazine, *Facilities Manager*, received an in-person briefing about PIER, the LRP, and products coming out of the program.
- **A major feature article** appeared in the July/August 200ue of *Facilities Manager* on the stairwell code change and the bi-level fixture. This article referenced the fixture performance monitoring at Evans Hall. (http://www.appa.org/FacilitiesManager/index.cfm?ItemNumber=1890).
- *Facilities Manager* also has a "New Products" page in each issue. The brochures and case studies for both the Watt Stopper Nightlight and the Finelite Integrated Classroom Lighting System were submitted to the editor of this page for possible publication.

BOMA

- Two meetings were held with BOMA staff contact, Bob Josephson, and the editor of *The BOMA Magazine*. BOMA was interested only in products that were available and suitable for the commercial building market.
- **A major feature article** was submitted to the BOMA for 2005 publication in *The BOMA Magazine*.

DOE

- Using materials prepared by the MC team, Karl Johnson of the University of California Office of the President's California Institute for Energy and the Environment (CIEE) gave a major briefing on the LRP to several DOE managers in the fall of 2003.
- The DOE Newsletter *PULSE* was initially considered as the appropriate vehicle for news about the LRP—particularly as related to work being done at LBNL. However, the MC team eventually determined this newsletter inappropriate for the target audience and purpose.
- Ron Lewis of DOE, who served on the LRP PAC, sent a package of key documents (the "Blue Folder") to the key managers in the DOE Buildings Division with a personal cover memo as to the importance of the work.

EPA

- Karl Johnson of CIEE briefed EPA about the LRP in the fall of 2003. EPA was most interested in the LRP's ENERGY STAR products. Those products developed slowly. Once prices and production schedules are set, it may be appropriate to revisit this contact.

IESNA

- Karl Johnson of CIEE and members of the MC team participated in the IESNA national convention, LightFair, in 2004.
- Karl Johnson and Kimball Hart submitted an editorial piece to LD+A columnist Bill Warren in anticipation that some version of that material would appear in Mr. Warren's column in the spring of 2005.

IFMA

- Three workshops for California IFMA members were held, with good participation for each.
- An article summarizing the workshop held March 2, 2004, appeared in the April issue of *IFMA News*.
- **A major feature article** appeared in the September/October issue of *FM Journal* on the broader LRP Program. The bi-level fixture, the nightlight, the classroom fixture, the DALI protocol, and the load-shedding ballast were all featured. All 18,000 IFMA members receive either an electronic or printed copy of the *FM journal*.

NECA

- **A major feature article** by Lewis Tagliaferre, based on information provided by the MC team, appeared in the July 2004 issue of *Electrical Contractor* magazine, a publication that goes to 90,000 readers. The article featured the three major LRP products then available on the market: bi-level fixture, classroom fixture, and hotel nightlight.

NEMA

- NEMA's principal interest was in supporting development of the DALI protocol.
- Demonstration of this new protocol was of keen interest to the NEMA audience. Because of this, the MC team stood ready to prepare an article for a NEMA publication. The timing, however, extended beyond the scope of the LRP contract period, hence the article was not written.
- NEMA would support a group purchase of dimming ballasts as a way to reduce costs. This is a concept that would be beneficial to several products of the LRP .

4.3. California Utilities as Key Alliance Partners

California's electrical power utilities are in some ways the most important Key Alliance Partners. Coordination with the utilities is a central goal for the LRP since, in California, four main investor-owned utilities and many other municipal utilities serve as a direct conduit to the customers for new technologies through incentive programs.

The three main investor-owned electrical power utilities (IOUS)—PG&E, SCE, and San Diego Gas & Electric—have a coordinated program for promoting new energy saving technologies through incentives. This program is divided into a number of areas depending on whether the incentives are directed at new construction or retrofit construction. The utilities have programs and personnel to promote the incentive programs with their customers. However, an important barrier is that the utilities are usually reluctant to promote any single manufacturer's technology directly due to requirements for avoiding favoritism.

Even if the utilities were interested in promoting one of the manufacturer-specific LRP technologies, they would be unable to promote the particular manufacturer that the LRP chose to help bring the technology to market. For PIER products, this concern is addressed by avoiding manufacturers' proprietary claims on products and making all project information available to competing manufacturers. Still, the utilities have been understandably cautious and typically promote innovations generically rather than specific-branded products.

The MC team began by directing its attention to the utilities' energy efficiency retrofit program since that program was designed as an itemized list of technologies that could be adapted to include some of the LRP products. The team worked with Express Efficiency program directors at the utilities to gain consideration of those LRP products. This process proved to be complex and somewhat variable among the different utilities. Because utility acceptance of these new technologies is so central to the success of the LRP, it was important to develop an effective pathway for integrating the LRP products into the utilities' own evaluation systems for bringing new technologies to market.

The MC team also dealt with the non-IOUs, such as SMUD and the municipal utilities of Alameda, Palo Alto, Lodi, and Pasadena. Typically, these organizations were willing and able to promote specific LRP products through demonstrations and via their own program. Some smaller utilities were also contacted and given information about the LRP products

near or at market-readiness. Some of the smaller utilities, such as Alameda Power and Telecom, expressed interest in supporting the LRP efforts and were willing to do their own demonstrations. Others based their program on that of the IOUs. This suggests another reason for more closely aligning the Energy Commission research programs with the utility programs, perhaps through their Emerging Technology teams.

4.4. Interactions with Other Important Organizations

As MC activity progressed, it became apparent that many more organizations could benefit from learning about the LRP. However, project resources were insufficient to address all these identified organizations.

The project team developed a strategy to at least provide basic product information to as many of these organizations as possible. In the end, responsibilities for this purpose were divided between the MC team and the individual product development teams:

- MC team: provided limited contacts with smaller non-IOUs, principally by mailing of descriptive information and inviting questions
- R&D teams: provided more intensive contacts specific to their products, as appropriate and feasible within project resources

4.5. Conclusions

The overriding conclusion of the Key Alliance Partners task is that there is great value in leveraging PIER market connection funds and capabilities by enlisting the interest and assistance of key industry associations, publications, and other natural allies in energy efficiency innovation. Significant valuable LRP product awareness and education have been delivered to the lighting industry and selected customer groups. Sustained PIER interest and goodwill have been generated among the LRP Key Alliance Partners. Those alliances should be nurtured for use in other PIER projects, since most have energy efficiency interests that extend beyond lighting.

The major California electric utilities are Key Alliance Partners in any energy efficiency technology market connection effort. To be effective, however, it is necessary to follow each product through the utility review, approval, and implementation procedures for new technologies. This effort requires working directly with the internal structure of each utility's energy efficiency programs and the managers of the relevant programs, ranging from the joint Emerging Technologies Coordinating Council to each utility's programs in Emerging Technologies, Residential (new and retrofit), Standard Performance Contract, Express Efficiency, and other topics. The MC team had substantial success in raising the visibility of several of the LRP products within the key utility programs and ensuring that the most advanced LRP products are in the utility approval process for the earliest possible implementation. Direct involvement of the product manufacturers also proved to be valuable in giving credibility to this effort.

The LRP's program and project summaries, website information, and the more complete media packages produced in another MC project task proved very useful in inciting interest

among the Key Alliance Partners. The materials were used extensively to brief AP representatives and leave behind as detailed background information for use in their articles, news items, and conferences.

In the last half of 2004, the Key Alliance Partner effort generated feature stories about LRP products in three of the leading trade magazines for facility managers and electrical contractors. The collective readership of these three magazines exceeds 100,000. Additional features are projected to be published in 2005.

Alliance Partners have been open to meetings and learning about both PIER and the LRP, but when it comes to publication, with the exception of DOE, the editors of the trade magazines want to feature only products that are available to members. For this reason, the bi-level fixture, the nightlight, and the classroom fixture have received a disproportional amount of attention in publications to date. Pending products still in the laboratory were not a highly desired feature topic.

Alliance Partners of significance, such as those identified in this project, generally do not have regional publications. To reach readers in California with the benefit of national recognition from the association, PIER must work through an association's headquarters, typically not located in California. While it can be very effective to address information to local California chapters of these organizations, which the MC team did in several cases, but that is a very labor-intensive process.

5.0 Outcomes III: Media and Outreach

5.1. Overall Outreach Strategy

The LRP's principal goal in information outreach was to ensure key LRP market facilitators were aware of all of the products and accurately informed about their individual advantages and market potential. This effort was intended to motivate those market facilitators to help accelerate market acceptance and commercialization.

A secondary goal was to inform the public about those innovative technologies, in anticipation of their market availability, both to generate demand and demonstrate the value of the PIER program's use of public funds. The information outreach effort also sought to assure political leaders and advocacy groups of the Program's accomplishments and beneficial effects on the state's energy and environmental goals.

5.1.1. Audiences, Needs, and Priorities

The many audiences for the LRP's information can be characterized broadly as:

- Supply chain actors
- Users of the products
- Others (often important for reasons broader than the market entry of single products)

All the audiences indicated in Table 4 were important. However, those indicated in **boldface** were designated early in the project as primary audiences due to their very high ability to leverage promotion of the use of LRP products.

Other key audiences were reached indirectly or through their own direct involvement. For instance, most projects had already developed connections to named manufacturers at the beginning of the LRP—although the MC team found that the interest of those initial candidate manufacturers often needed to be nurtured. These other audiences were addressed as opportunities arose, but with less emphasis.

Table 4: LRP audiences

Key LRP Information Audiences (bold indicates primary audiences)	Main LRP Information Needs of Each Audience
Supply	
Manufacturers	Manufacturability, costs, market, overall business case
Marketers and distributors	Market readiness, competition, profitability, channels
Codes & standards specifiers	Code changes needed, installation, safety risks
Lighting-related profession media	Overall business case, user interest and value, features
Users	
Application designers/specifiers	Standard specs, applications data, design tools, user value
Major building developers	Bottom-line impact by ownership scenario, value sources
End-user owners and tenants	Impact on total occupancy costs, safety, productivity
Technical educators	Advantages, applications, requirements for specification
Others	
General public	State working for people; useful new products coming
Public policymakers	Evidence of good use of LRP funds; market successes
Energy and environmental advocates	EE benefits, practical uses, market potential
Potential PIER cofunders	Demonstration of workable partnerships

5.1.2. Media, Channels, and Priorities

Channels provide further focus by referring to all the specific ways that messages and information products reach audiences, including specific classes of intermediaries—such as trade and professional societies—using the Internet, direct mail, events, and specific targeted publications. In consideration of those audiences and their media habits, the following media and channels were the focus of the LRP outreach effort:

- **Print materials**: Media packages and press releases were developed for trade and professional journals and newsletters, as well for distribution at various events including LightFair, ACEEE, and the Emerging Technologies Summit.
- **Web materials**: The MC team revised selected LRP website content and layout (for researchers, public policymakers, and public) and provided content to other websites of professional groups to support the print media outreach to those key implementing audiences.
- **Alliance-building support**: The MC team provided materials to support Alliance Partner efforts on LRP's behalf. The team used one-on-one contact with leaders in trade and professional groups to gain access to their members and standards-related committees via their media and events such as conferences.
- **Direct outreach**: The team developed and used standard presentations for broad LRP use as opportunities arose to present results.

5.2. Broad Outreach Activities and Results

The main early outreach efforts demonstrated the ease and practicality of producing product brochures and identified venues and schedules for future presentations to key industry audiences. A standard set of computerized slides for all LRP participants was developed to describe the LRP in any presentation. The individual R&D project leads informed the team of any preferred presentation venues, and BKi compiled a list of alliance-based opportunities for presentations and other outreach.

Because staff time resources were limited compared to the large number of projects in the program, the MC team leveraged presentations and other media efforts for maximum value. At each presentation and conference, the MC team brought materials to not only highlight the particular products on display or being discussed, but also provide an overview of other products and the LRP as a whole.

5.2.1. Media Packages

The MC team produced a series of customized media packages to be distributed at events and delivered to Key Alliance Partners. The content and format of these packages were tailored to the audiences and needs of the individual outlets and channels. LRP products were grouped by audience relevance and availability for use in these packages. The typical media package included a summary news release, an LRP description, fact sheet/brochures on specific products and their status, photos, information on the partner programs such as ENERGY STAR, a summary sheet with most of the projects listed, and referral instructions for further information.

The kits were widely distributed at various events throughout 2004:

- About 30 of these kits were distributed at the IFMA meeting in March.
- About 300 copies were distributed at LightFair.
- Multiple copies were given to each of the Alliance Partners.

- Over 100 were given out at the Emerging Technologies Summit.
- Further copies were distributed at the Energy Management Congress, a University of California System conference on Sustainability.
- Kits were distributed at the ACEEE Summer Session and various other events that involved LRP products.

Altogether, well over 500 such kits were distributed during the program.

As part of the outreach effort, the MC team developed and periodically refined an illustrated LRP Products Summary document detailing all the products under development. This short summary document provided a means for quickly communicating the full scope and diversity of the LRP to all interested parties. The team later expanded this Project Summary document to serve as the first access point for people seeking information about the LRP on the Internet.

5.2.2. Cross-Program Coordination

With aggressive outreach by the MC team plus the LRP manager's regular element lead conference calls, the individual R&D project and element leads generally kept the MC team up to date on major advances and newsworthy events within their projects. The MC team also surveyed the project leads periodically to inquire about upcoming events, recent accomplishments, possible ways to help, and general brainstorming discussions.

Wherever feasible within the budget, the project leads were encouraged to channel their outreach through the MC Project's planned outreach efforts, which reduced some of the project lead's costs and helped to assure consistency of LRP image and communications quality.

5.2.3. Website Content Development

The LRP built a substantial body of documentation to support each project in the program. Access to this information is provided on the project website (www.archenergy.com/lrp) and was continually updated by AEC over the course of the contract period. Upon completion of the project, AEC provided the Commission with a final disk copy of the website. Early in 2004, the MC team reviewed the program documentation and sorted it into five categories:

- Products for sale
- Products likely to be for sale by end of the LRP in late 2004
- Products in the pipeline with possible prototypes by late 2004
- Research and technologies with reports due in 2004

These categories were then used to shape communications with the publics, including the Alliance Partners. Many partners had been interested only in products that were immediately available. In other cases, they wanted to know what products were on the horizon.

This approach was also used to overhaul portions of the website so those unfamiliar with the LRP could find product-related information quickly. BKi designed a new website format that

separated the LRP products based on market-readiness and included the simplified descriptions from the Product Summary sheet. The web content included technical information and data for the professional applications community—manufacturers, marketers, standards-setting groups, and designers—and major potential users.

The MC team also investigated the use of a web-based interface for facilitating communication between the R&D and MC teams. However, this proved impractical due to the differences in communications modes and styles among the project leads. The larger project goal of this project of maintaining lines of communication between the MC team and each of the project leads was accomplished through direct outreach.

5.2.4. Use of Events

Further promotion of the LRP was accomplished by representing the program at various industry events to help spread the word about the program as a whole and about specific project being developed in the LRP. Some of the more prominent events are highlighted below:

AEE World Energy Congress (Atlanta, November 2003)

A major commitment of time was given to attend the AEE trade show in Atlanta, the World Energy Congress, November 17–19, 2004. Much PIER and LRP literature (~100 media packages) was distributed to attendees.

West Coast Energy Management Congress (November 2003)

A member of the MC team attended to survey the conference as a possible venue for 2004 and to gather information about possible competitive technologies.

IFMA Meeting (March 2004)

The MC team supplied 35 media packets for attendees at the IFMA meeting.

LightFair (March/April 2004)

The goal of attending LightFair was threefold:

- Publicize the LRP generally
- Assist LRP project leads in providing information to conference attendees
- Gather information on new projects

BKi prepared and brought 300 brochures to LightFair and delivered them at each of the LRP-related sessions, distributed them at a number of booths throughout the showroom floor, and talked with manufacturers working on technologies complementary to those of the LRP. All new information gained at LightFair was shared with the appropriate LRP project leads.

Lighting Controls Event, Pacific Energy Center (April 2004)

The MC team made media kits and brochures concerning the LRP products available to participants at the event. Several LRP project leads gave presentations at the event.

SF Environmental Department - Hotel Event (May 2004)

BKi worked with the Department of the Environment, City and County of San Francisco, to try to find a way to get hotels to adopt the hotel nightlight through a group buy. The bi-level fixture and ENERGY STAR fixtures were promoted also at the event.

Energy Management Congress (July 2004)

LRP materials were present at Lamar Lighting's booth and the MC team collected information on other technologies and companies present.

University of California, Sustainability Conference (July 2004)

The MC team had a booth and was able to display some of the LRP technologies including the bi-level fixture. Brochures were available from most projects in the program as were some media packets and brochures from other Energy Commission PIER projects. Presenters were asked on both days to mention the LRP. A number of facilities managers from the UC system visited the booth and received demonstrations of the products.

ACEEE Summer Session (August 2004)

In September 2003, the LRP Management decided to make ACEEE's 2004 Summer Session a central event. It was to occur in August 2004, when most of the LRP projects would be completing their work and demonstration units would be available for many products. For this reason, various LRP projects were included in the ACEEE event, including papers, poster sessions, and individual product developer exhibits, as well as an LRP product exhibition booth.

A paper was presented on the LRP by the management team. In addition, members of the MC team presented other papers on aspects of the MC approach and specific product results. At the LRP exhibition booth, products on display included the LED exterior lamp, low-profile LED fixture, hotel nightlight, ENERGY STAR lamps, and the bi-level stairwell fixture. Information brochures on these and the other LRP projects were also available.

Other Events

- Many of the LRP product information items used at ACEEE were also shown at the final PAC Meeting at the new California Lighting Technology Center in Davis.
- The MC team distributed some 75 information packets at several IESNA meetings and 100 at the inaugural national ACEEE Emerging Technologies Summit in San Francisco (October 2004).
- The MC team also provided information and marketing materials to Dave Wiegand of the New Buildings Institute to make presentations to three California chapters of the IES.

6.0 Conclusions and Recommendations

6.1. Conclusions

The objectives of this *Program-Wide Market Connection System* project were to:

- Create, implement, and evaluate a new coordinated and intensive method of fulfilling the technology transfer requirements of the PIER Program.
- Provide specific expert guidance to the Program manager and technology developers on practical product specifications and economics needed to maximize market success.
- Build alliances with key institutional intermediaries, including efficiency advocacy groups, energy professional and trade associations, and governmental regulatory authorities at all levels.
- Provide consistent and appropriate information in effective media forms to relevant market actors and consumers to enable understanding and acceptance of all Program products.
- Provide developers of selected earliest program products with expert guidance on accelerating products toward effective market preparation and entry.

In this concluding chapter, the project's accomplishments will be reviewed in the context of each of these objectives. Comments and recommendations will be provided for future Market Connection activities.

6.1.1. Innovate to Meet PIER Technology Transfer Needs

Innovation in Planning and Feedback

The BKi project staff created a new approach to preparing the Energy Commission's required Technology Transfer Plans for each R&D product by developing a fully formatted LRP report template including a detailed outline of content items and instructions. A spreadsheet process was also developed to guide the R&D projects in doing the required basic economic justification for their products. The content was extensively reviewed and refined in early use and provides a model for further adaptation and use in future PIER programs. Not all projects will need such complete detail, but it demonstrates the full range of business case content often considered in the commercial R&D world.

The BKi staff was responsible for providing guidance and review for the R&D projects to help ensure minimal standards and consistency. BKi also drafted TTPs, including the economic analysis, for several of the products to demonstrate the practicality of the approach and to provide concrete examples for the other projects.

By insisting on early submittal of the draft TTPs, the MC team was able to provide information to program management on products that needed further review and possible revision. Too often in the past, technical projects submitted TTPs near the end of a project—when it was too late to incorporate their findings into the product—and in very incomplete detail that greatly limited their usefulness to potential manufacturers and others interested in

market implementation. PIER had no acceptable models for either the TTPs or the feedback value of such analyses prior to the LRP, so there were no standards for either the plan or the process of its use. This project's TTP template, examples, and feedback findings provide a basis for improving this situation more broadly in PIER.

Perhaps the most important result of this TTP approach was the education it provided to the R&D project leads and the LRP staff. The efforts and resulting draft plans submitted by the LRP projects early in the program, using this template, demonstrated that in many cases inadequate time had been given to product marketability screening prior to the start of the R&D itself. This is common; many researchers operating in the public sector are inexperienced in the rigor of market and business case development for their R&D products, and this TTP template's content outline clearly presents all the elements that should be considered.

The TTP template and feedback process can and should evolve with use by others. The template is extensive in scope, and in some projects a more limited or focused content might be more practical yet still valuable. The important point is that it now exists and demonstrates the range of issues and analysis relevant to such plans and business case development.

Innovation in Actions

In its market connection activities, the MC project team emphasized the use of Key Alliance Partners to leverage its limited funding through expanded product publicity within the lighting world. Such leverage is easily developed through direct contact with key organizations and demonstration of the value of the products. In addition to the team's work with those Alliance Partners, the individual R&D project teams were also enlisted to provide updated information as needed and to carry out similar initiatives on their own. Several were active in LightFair and other conferences and some also worked directly with industry publications.

The MC team also stressed the importance of direct connection with key California electric utilities, and worked extensively throughout the project to identify the key actors within each major utility, keep them informed on progress and push for early recognition and inclusion of LRP products in their own testing, approval, and incentive setting activities. This is apparently resulting in accelerated approval for some of the earliest LRP products.

The MC team took a direct approach with manufacturers in addition to its ongoing coordination with the R&D organizations in the LRP. The team made and maintained direct connections with many of the manufacturing partners in the LRP product developments. Several manufacturers made substantial use of the analyses, data, descriptive materials, and recommendations on contacts and actions in market development. This direct connection to manufacturing partners was also found to be very valuable to the program for independently gauging progress of the various projects.

6.1.2. Feedback on Product Features and Economics

Early in the program, the MC project reviewed all the proposed R&D products and provided feedback to selected project leads on potential refinements of product design and market targeting. In some cases, this involved review of the TTPs. In cases where the TTP was not yet available or adequately detailed, the MC team increased its interaction with the project lead and manufacturing partner and made use of the economic analysis method developed for this purpose for projects that lacked adequate data.

The principal conclusion from this effort is that such feedback to the R&D projects is a valuable service of an independent market connection activity. In the LRP, this feedback led to significant early changes in some R&D projects. The MC team function continued throughout the program as further research and interactions with the manufacturers defined the products in greater detail.

6.1.3. Alliances with Key Institutional Intermediaries

This MC activity developed a very strong set of alliance partners that could be tapped for future R&D programs. All were provided with detailed information on LRP products relevant to their needs. The team had moderate success in getting them to help educate their members by publicizing this information through their professional media and events. However, a key finding was that such activities take considerable time to develop and translate into actual media outreach by the allies. This is an indication of a broader need, which is to extend market connection activities well beyond the term of the R&D programs served.

Utilities proved to be the most important and effective allies. The MC team identified the overall utility process for product approval and inclusion in incentive programs and worked with all key IOU managers to place LRP products. This, too, is a slow process requiring close personal efforts with each utility and their key product handoffs from assessment to incentive program placement. Most PIER projects in building energy efficiency product development would benefit from such attention.

6.1.4. Create and Use Media to Educate Key Audiences

A major activity of the MC team was developing and regular updating of informational materials, including media packages, website materials, and presentation materials. The team found a shortage of effective industry media but distributed media packages widely through direct contact with intermediaries as a complement to the media contact effort.

The team did extensive in-person outreach through exhibits, presentations, and handouts at lighting profession and end-user events. Several product brochures were created by the team as examples, and others subsequently developed by R&D teams were reviewed and refined. The standard set of PIER informational documents, such as brochures and fact sheets should be reviewed, along with their audience targets, to develop additional documents more useful to the broader professional energy efficiency community.

6.1.5. Help Move Market-Ready Products into Use

The MC team also found valuable opportunities to provide extensive support to manufacturers of all near market-readiness products. This support included supply media and advisory services to help move products into utility programs and overcome concerns of wary specifiers and buyers. This effort took a major share of the MC project resources but was seen as a valuable service.

Concerns about the market advantages thus provided to those manufacturers seem in BKi's experience to be misplaced, since at this early stage of product development and introduction, the market's acquaintance with the products is in the interest of all competitors who may later enter with variations. This is further supported by the PIER program's policy of limiting proprietary claims and making the details of all innovations available to other suppliers.

6.2. Recommendations

As indicated in the previous paragraphs, the market connection activity met its objectives effectively. But there were also some shortfalls in the program that provide lessons for future PIER Buildings R&D. Several recommendations are discussed below.

The separate market connection element of the LRP was a bold step for PIER. Much was accomplished, but the effort may have been more effective with additional resources. However, it is difficult to quantify the results of the LRP MC efforts especially in the short term.

In addition, the time period for the market connection effort seemed short, since most of the R&D products were not ready for effective market connection support until near the end of the program. It should be noted that market connection activities by researchers and manufacturers needed to extend well after this program because of the LRP products that had entered or were about to enter the California market.

The overriding conclusion of the Key Alliance Partners task was that there is great value in leveraging PIER market connection funds and capabilities by enlisting the interest and assistance of key industry associations, publications, and other natural allies in energy efficiency innovation. Significant valuable LRP product awareness and education were delivered to the lighting industry and selected key customer groups. Sustained PIER interest and goodwill have been generated among the LRP Alliance Partners. Those alliances should be nurtured for use in other PIER projects, since most have energy efficiency interests that extend beyond lighting.

The major California electric power utilities are Key Alliance Partners in any energy efficiency technology market connection effort. To be effective, however, it is necessary to follow each product through the utility review, approval, and implementation procedures for new technologies. This requires working directly with the internal structure of each utility's energy efficiency programs and the managers of the relevant programs, ranging from the joint Emerging Technologies Coordinating Council to each utility's programs in

Emerging Technologies, Residential (new and retrofit), Standard Performance Contract, Express Efficiency, and other topics.

Other specific recommendations are:

- Use the TTP template as a benchmark for future projects.
- Continue to make the MC work independent of the technical projects, similar to an evaluator but with responsibility for business cases and building market momentum.
- Dedicate an appropriate amount of funds to direct market connection efforts.
- Extend MC efforts beyond the timeframe of the R&D elements.
- Involve utilities earlier in all energy efficient product-oriented R&D projects, especially in the design and responsibility for field tests and product descriptive media (brochures).

6.3. Benefits to California

Statewide benefits from the activities accomplished under the market connection projects are the expected acceleration of the acceptance and adoption of the LRP technologies and products. Market penetration estimates for the California marketplace have been set at 1% for all the LRP projects. However, some products may see up to 5% market penetration due to the quality of economic analysis and code and standards research, market tools developed, and outreach activities completed under the individual research and the market connection projects.

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8.0 Glossary

ACEEE	American Council for an Energy-Efficient Economy
AEC	Architectural Energy Corporation
AEE	Association of Energy Engineers
AIA	American Institute of Architects
ALA	American Lighting Association
APPA	Association of Higher Education Facilities Officers
BKi	Bevilacqua Knight, Inc.
BOMA	Building Owners and Managers Association
CFL	compact fluorescent lamp
CPUC	California Public Utilities Commission
DOE	U.S. Department of Energy
Energy Commission	California Energy Commission
EPA	U.S. Environmental Protection Agency
ICLS	Integrated Classroom Lighting System
IFMA	International Facility Management Association
IESNA	Illuminating Engineering Society of North America
IOU	investor-owned utility
LED	light-emitting diode
LRP	Lighting Research Program
MC	market connection
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
PAC	Program Advisory Committee
PGC	Public Goods Charge
PG&E	Pacific Gas and Electric Company

PIER	Public Interest Energy Research
R&D	research and development
RD&D	research, development, and demonstration
SCE	Southern California Edison
SMUD	Sacramento Municipal Utility District
SPM	California Standard Practice Manual
TAG	Technical Advisory Group
TRC	Total Resource Cost
TTP	technology transfer plan

Appendix A: Guide to Working with the Market Connection Element

Market Connection and YOU:

How to work with Element 6

May 14, 2003

What This is For

This little procedural guide is intended to help all the LRP developmental projects get the most out of the program's separate Market Connection ("MC") resources. The Market Connection function, LRP Element 6, is a new approach for the PIER program. It's there to help improve the chances that LRP products will move beyond the lab and out into the marketplace successfully. It's also a trial run of this approach, and as such we will probably find ways to improve it over the course of the program. We all know that more emphasis on market connection is needed in the LRP, just as in all applied PIER R&D, but we need everyone's help so that we will end up with a model that the Energy Commission can use with real confidence in its future programs.

This guide will be updated periodically as needs arise. Suggestions are welcome: Contact Bob Knight at rknight@bki.com or 510.444.8707 x223.

What's Included Here

Basic principles for market connection efforts

What exactly does Element 6 do?

Specific help with your project deliverables

Help with information outreach activities

General coordination between technical and MC teams

Basic Principles for Market Connection Efforts

All your work with the MC element is a part of your project's Technology Transfer task.

The market connection (MC) people are your allies, not your adversaries: Use them!

For efficiency, technical projects should share data and status information with Project 6.1 routinely—reducing the need for special requests and needless time spent by all.

MC staff will release no findings or conclusions on your project without your prior involvement.

All news releases, articles, papers and presentations must be coordinated with AEC in advance, just so the prime contractor, the client, and the MC staff can assure some consistency program-wide.

Most of the market connection efforts will be focused on the products closest to production but all projects can get some help.

The MC people can make your job easier; call BKi for help on any market-related issue. They can't do everything for you but they are there to help. Take the initiative; don't wait for them to call you.

What Exactly Does Element 6 Do?

General Division of Market-Related Responsibilities

The technical projects are still *responsible* for their technology transfer; Element 6 provides expert help and emphasis on information outreach, business case development, brochures, access to market allies, and strategic planning of future product development and commercialization.

The Element 6 Leader

Bob Knight leads the Market Connection Element (rknight@bki.com, 510.444.8707 x223). The LRP's early experience shows that the Element 6 EL needs to have close coordination with all the other ELs. In fact, each of those ELs is likely to be more involved with Element 6 than with each other. The same may prove to be true for the project leads as well, who may need to work more with Market Connection staff than with other technical projects.

This "many-to-one" asymmetry puts a strain on the EL6 budget, so it needs to be efficient. Everyone is encouraged to deal directly with any of the Element 6 PLs and staff—but when in doubt, call Bob. Also, everyone should also try to get into the habit of routinely copying Bob on emails and other materials that may be related to the market connection element. Such information could range from product functions, advances, and economics to competitor information, market statistics, and test/demo results.

The Market Connection Support Project (6.1)

Bret Logue of BKi manages this "umbrella" market connection project. (blogue@bki.com, 510.444.8707 x209) Bob Knight also oversees and participates in this work, and Kim Hart (HMP) is a subcontractor. This project provides a variety of support to the technical projects. Much but not all of that effort will be focused on the products whose development is closest to market readiness. This is already well underway with 4.1, 4.5 and 5.1, and will probably also involve some others.

This project is also responsible for the LRP's overall public communications strategy and coordination, ranging from press releases to web information and some presentations for market-development purposes. Another BKi function is to help the technical projects with their responsibilities for economic rationales, tech transfer plans, and production readiness plans. Call Bret Logue at BKi with any questions or needs for help.

The Design Tools Project (6.2)

This project is run by Caroline Clevenger of AEC (cclevenger@archenergy.com , 303.444.4149). She has conducted a survey of lighting designers to gauge their use of computerized design tools and how to make them effective in encouraging the use of new lighting products in general. All PLs and ELs should be informing her of products' opportunities or needs for new design tools to help lighting professionals understand and specify those LRP products. Ultimately this design tools project must allocate its very limited tool-building resources to a few selected tools, so if you think a new computerized design tool may be important for the success of one of your products you should make a pitch for it.

The Codes and Standards Project (6.3)

Doug Mahone of HMG is the project lead (dmahone@h-m-g.com , 916.962.7001). Earlier in the LRP, Doug produced a very good sourcebook on relevant codes and standards processes. He, like Caroline, will be reviewing in-progress LRP products for the next several months and will make recommendations on those that appear to benefit the most from his help. If you have specific interests or concerns about codes and standards issues, call him. As in Caroline's project, Doug must focus his efforts, so make your pitch to him if you need some specialized assistance with codes and standards issues.

Help With Your Project Deliverables

All the technology development projects are required to submit a brochure, a tech transfer plan (which includes a simplified business case rationale), and a production readiness plan. Project 6.1's scope includes help with preparation of those items.

Standards and Approach for Product Brochures

Each project is required to produce a product brochure; the BKi project is responsible for editing and final formatting for delivery. We need to get some of these brochures done in 2003, particularly those for the early-to-market products (4.1, 4.5, 5.1). This is a very simple task, using the brief Word brochure template provided to all PLs. No graphic artist involvement is required in most cases, and the template requires less than a page of text (about 400 words max). As in the case of news releases, it is best for the PL to draft the brochure using the template. E-mail it to Bret at BKi, who will review, edit, fine-tune the format and return it for review and approval before delivery to the Energy Commission.

Doing Early Product Business-Case Analyses

By the end of this July, as noted in the Critical Program Review Action Items, the Energy Commission requires each project to deliver an economic "business case" analysis as a part of their basic technology transfer planning obligation. This economic analysis should provide a basic justification for the product development effort. These business case analyses or rationales are going to be varied in detail, depending on each product's state of development and likely market timing. Most of you already have the justification outlined, whether or not it has been fully written. All technical projects should provide that information to BKi as

soon as possible so that the Market Connection staff can work with you to help refine it for submittal on time. (draft template to be provided)

Standards and Approach for Technology Transfer Plans

Each project is required to produce a Technology Transfer Plan by August…not much time left! These should be drafted as early as possible, and BKi will contact project leads to encourage and help. BKi is proposing a brief template (draft to be provided) that indicates structure and main content items. We recognize that they won't all look the same; this template accommodates both near-commercial products and others still far from a final configuration and market entry.

After receipt of a draft Technology Plan, BKi will review it and work with the developer on refinements. The developer will then submit it to AEC (with a copy to BKi) for delivery to the Energy Commission. The same process will be followed for the final version.

Standards and Approach for Production Readiness Plans

Same as for the Technology Transfer Plans. However, these are not required until near the end of the program.

Help with Information Outreach Activities

The technical project leads are encouraged to develop technical papers, presentations, and news items for the technical press. Project 6.1 also provides help and coordination of these activities, in cooperation with AEC.

Production and Distribution of Product-Related News

LRP product-related news includes news releases, interviews, web announcements and other short written, aural or video pieces. These tend to be episodic/timely, brief, highly focused and newsworthy, and targeted at a broad public audience or media. They may be originated or written by anyone in the LRP; for example, either a PL for a specific product or a market connection staff person may propose an announcement concerning that product.

Here's the recommended approach for technical projects: When you have a newsworthy item, such as a successful field trial or a cost breakthrough, simply call BKi to discuss how best to get the news out. You may find it easiest to draft the item instead of feeding all the information to BKi so they can write it, but either will work. Then BKi will produce a polished draft and send it back for approval.

The Energy Commission asks that we be consistent and professional in all news item production and placements. All LRP efforts are to involve a central clearinghouse (which is AEC) where all news items are sent for review prior to publication. AEC will work with BKi to edit, reach agreement with the project involved, and distribute the news item to the LRP list of relevant contacts (courtesy of NBI). PLs may do further distribution if they desire.

Professional Papers, Articles, and Presentations

Your subcontracts encourage professional outreach, both individually and through BKi. If you plan to present a paper or presentation for LRP at an upcoming conference, please let BKi know. Please discuss each opportunity with BKi to see how they may be able to help. The BKi contract does include some help (largely from Kim Hart) in finding opportunities with key allies and even making some limited presentations. BKi is developing a list of possible opportunities to add to your own.

Please notify AEC well before any professional submittals and events, and provide a copy of the materials to be used. These will be reviewed only to assure some basic consistency and appropriateness of style and editorial content; technical content is the PL's province. The subcontractor's name can be used in such professional outreach efforts but active self-promotion will be discouraged. The PIER program and the LRP should be cited as well as the prime contractor (AEC), sponsoring entity (Energy Commission) and program (PIER-Buildings) in all such outreach efforts.

General Coordination between Technical and MC Personnel

All the Element 6 projects need as much market-relevant data and information as you can give them—as well as any new developments that may affect market readiness and targets. Please remember to include Bob or Bret in your routine distributions of such information. They can pass it on as needed. Also please take the initiative to send them background studies and data that you think are particularly important to your project. The MC staff will keep all such data and information private within the LRP unless/until all parties agree to release it. You will probably get calls and emails from them periodically with questions. But their work is intended to help make your product as successful as possible with the least possible effort from you—so take the initiative in communicating with them rather than waiting for them to call you.

Element Leads: Encouraging the PLs to Work with the MC Element

The Market Connection effort will depend on the support of all Element Leaders to assure open and constructive relationships between the PLs and the MCs as well as clear and timely information from each project. This requires only that the ELs be alert for opportunities for their projects to make use of the MC services and to provide relevant data to the MC projects.

Everyone: Evolving the Market Connection Model

The ELs and PLs are encouraged to help identify opportunities for improving and refining the Market Connection approach and services. This includes the PLs' bringing any such ideas to their EL, even if the PL is also dealing directly with Bob Knight. Direct PL communication with Bob is okay, but the relevant EL needs to know what's going on.

Keeping Bob in the Loop

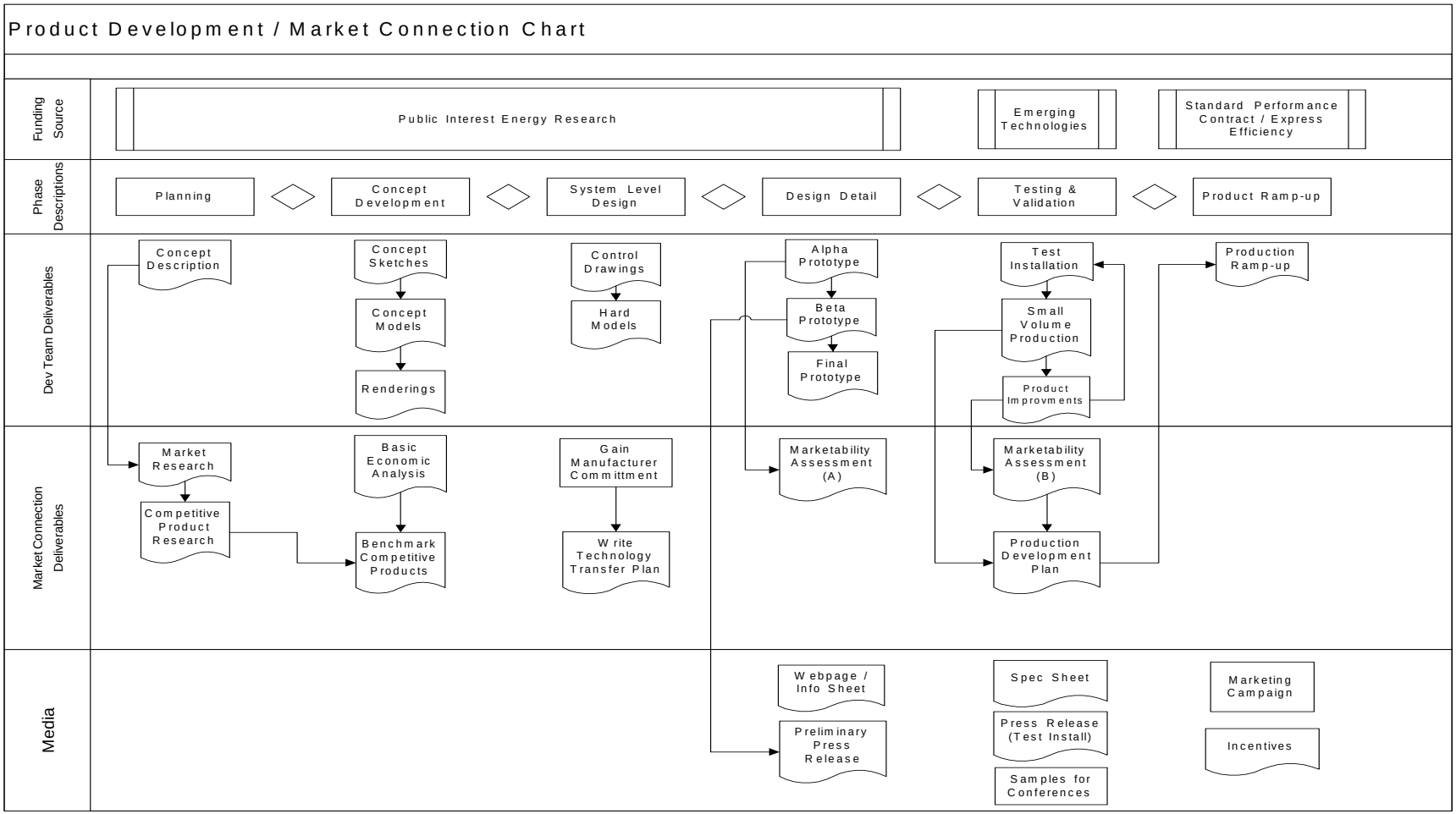
Please be sure that if ELs or PLs are dealing directly with Projects 6.2 and 6.3 (i.e., non-BKi activities) they also keep Bob Knight informed—generally via email copies. But there's no

need to force everything through Bob in order to get to one of the Element 6 projects. Just help keep him aware of what's going on.

Keeping the Technical ELs in the Loop

Same principle: In general, PLs should keep their EL informed of any activity with Element 6. For example, when sending information to Element 6, PLs should copy the appropriate EL on the correspondence. But the PLs don't have to route all their market connection needs *through* their EL. Just keep each other informed.

Appendix B: Product Development/Market Connection Chart


Product Development / Market Connection Chart
Funding Source
Public Interest Energy Research
Emerging Technologies
Standard Performance Contract / Express Efficiency
Phase Descriptions
Planning
Concept Development
System Level Design
Design Detail
Testing & Validation
Product Ramp-up
Dev Team Deliverables
Concept Description
Concept Sketches
Concept Models
Renderings
Control Drawings
Hard Models
Alpha Prototype
Beta Prototype
Final Prototype
Test Installation
Small Volume Production
Product Improvments
Production Ramp-up
Market Connection Deliverables
Market Research
Competitive Product Research
Basic Economic Analysis
Benchmark Competitive Products
Gain Manufacturer Committment
Write Technology Transfer Plan
Marketability Assessment (A)
Marketability Assessment (B)
Production Development Plan
Media
Webpage / Info Sheet
Preliminary Press Release
Spec Sheet
Press Release (Test Install)
Samples for Conferences
Marketing Campaign
Incentives

Appendix C: Technology Transfer Template

PIER Lighting Research Program

California Energy Commission
Contract # 500-01-041

Draft Technology Transfer Plan

For Project X.X

[insert project title]

Deliverable x.x.x

[insert date of your draft; this template's date is 6/21/03]

Submitted To:

Accounting Office, MS-2

California Energy Commission

1516 Ninth Street, 1st Floor

Sacramento, CA 95814

Submitted by:

Prime Contractor:

Architectural Energy Corporation

2540 Frontier Avenue, Suite 201

Boulder, Colorado 80301

Responsible Subcontractor:

[insert organization name and address]

Table of Contents

(NOTE: The headings are set to allow automatic generation of this table under "Insert")

1. Introduction and Summary 4

2. Business Case 5

3. Market Analysis 7

4. Current Product Development Status and Needs 8

5. Technology Transfer Actions 9

Appendix I: Simplified Economic Analysis for Tech Transfer Plans 11

Appendix II: CPUC Avoided Cost Table 19

List of Tables

(may be inserted as needed)

TECHNOLOGY TRANSFER TEMPLATE DEVELOPED BY BEVILACQUA-KNIGHT, INC.

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Notes on Using this Technology Transfer Plan Template:

This template is provided to help you produce a good—and quick—early draft of your required Technology Transfer Plan by the end of this summer. Complete what you can, indicate your current thoughts on other items, and insert any comments or questions that would help refine the template itself.

The first section focuses on making the business case for the product BEFORE describing the plan for its commercial introduction. This first "action item" is essential. It provides the rationale for arguments to move the product past the barriers in the path to market. An economic justification should be possible even if assumptions (clearly identified) are needed for some key variables.

It is important that project managers think broadly about their product's benefits. Sometimes the key determinants of value have little or nothing to do with energy efficiency; some users may value an LRP product for its environmental image-building properties (e.g., a hotel chain seeking to "look green"), worker safety, productivity enhancement, or status as an innovator.

Not every product has to have a detailed economic justification. Some LRP products are only components of larger products or systems yet to be developed, and in some cases those ultimate consumer products may not even be known yet. In such cases only the most general economic case can be made—but the attempt should be made, including clearly identified assumptions for the unknowns.

This template suggests the main types of tech transfer activities needed to capture the current views of the product developers for the consideration of manufacturers and other key actors. The intent here is to encourage the developer to think through the process and to develop a full vision of the product's necessary path to the market. For this draft, you are not expected to know all the specific policy interventions, media, messages, channels, timing, expenditures, and division of responsibilities. Where these details can be described now, they should be…but the intent here is only to see how far your thinking has developed at this early stage and to give you a good start on refining that thinking before the final Technology Transfer Plans are due next year.

(continue next page)

Technology Transfer Plan

For Project X.X

[insert project title]

1. Introduction and Summary

Technology Transfer Plans in the LRP

This is one of a series of Technology Transfer Plans in the PIER Lighting Research Program. In the LRP, "technology transfer" is defined broadly to mean everything needed to move the product from its current developmental state to successful market introduction. Each of the LRP's technology transfer plans addresses one of the LRP's technology or protocol products, and provides an overview of the product's development status, markets, and business case. Most importantly, it identifies specific actions recommended to encourage the product's production and successful market introduction in California.

This Product

What is this product, in a single sentence? And is it a complete end-use product or system, a separate component for the OEM market, a protocol or standard, or something else?

(Include a photo and/or diagram if readily available)

Function and Features

What lighting function does this product serve? For what general markets and uses? If it's a component, what ultimate products will incorporate it, and for what purposes? What are its main features?

Tech Transfer Action Summary

Fill in the boxes to briefly summarize the plan and highlight specific action items. Delete or alter elements as appropriate.

Plan Element	*Action Needed*	*Actors/Approach*	*Notes/Comments*
Refining Product to Meet Market Needs	*Note any features to be added, change in target markets, etc.*	*Current developer vs. manufacturer, etc., when and how*	*Note if critical need or especially difficult*
Gaining Commitment of Manufacturer(s)	*Cite present manufacturer commitment status, candidates, etc.*	*Who, how, and when to get commitment, how to seek, etc.*	*Firmness of present commitment, use of business case, etc.?*

Developing Codes & Standards Support	*If already adequate, say so; otherwise summarize needed changes*	*Identify who should lead this effort, what they should do, and when*	*Why this may be needed, and how difficult or slow?*
Establishing Utility or Other Incentives	*Gain approval from CA utilities to provide incentives to purchase*	*Say who is best placed to make and endorse the case, and how*	*Note how long this might take and how soon it could start?*
Assuring Product Value to Customers	*Demonstrate case for net economic gain and other valued benefits*	*Perhaps further cost analysis, case studies, etc., and by whom*	*Note possible market expansions with new pricing or features?*
Motivating Lighting Designers/Specifiers, Other Key Actors	*Actions to convince of value, ease of specifying, risk protection*	*Propose design tool, warranty, etc.by mfr, use of case studies…*	*Emphasize timing and effort importance?*
Educating and Motivating Buyers	*Effective outreach actions to present case for the product's value*	*Proposed marketing efforts by mfr. beyond routine level, if any; list items briefly*	*May just cite page of detailed discussion later in report, if needed?*
(Other Key Elements, if any)			

2. Business Case

This section presents an economic analysis to demonstrate the product's value for both the manufacturer and the consumer. An **Excel spreadsheet template** is provided separately as an easy way for you to do the minimum calculations needed; you can refine the methodology as needed. **Appendix I** to this report is a guide that will help explain the function of each column of the spreadsheet. The paragraphs below depend on its results—and also give you a place to explain the reasoning behind your numeric assumptions in the calculations.

Product Scenarios

For most products, you probably won't be able to predict the "right" combination of key features and market applications. Therefore it's usually important to define more than one scenario, so that you can at least bracket the range of possibilities. For instance, with the bilevel stairwell fixture, there are both new and retrofit markets, each with different installation costs as well as competing products (for new construction) and existing fixtures (retrofit).

The market sizes and absorption rates also differ and have their own uncertainties. All these differences have big effects on the economics. But there's no need to try to analyze

every possibility—just to show the effects of the main uncertainties. Imagine that you're trying to convince a manufacturer to invest in making and selling the product, and do only what you think it would take to demonstrate an attractive business case.

Supplier's Product Costs and Price

Estimate the cost to make, deliver, sell, and support the product, including minimum acceptable margins for the manufacturer, distributor, agent, and installer. Include assumptions to the extent that the cost components are not readily available or estimable. Identify any major unknowns in the estimated cost. Depending on the application, pricing may be trade or retail.

Consumer's Installation-Related Costs

Costs of installation, commissioning, and other one-time costs should be estimated separately for new and retrofit cases, as applicable. For example, usually in retrofit jobs the cost must include both the installation of the new product and demounting and disposal of the existing product. In new construction, the installation cost is reduced by the avoided cost of installing the conventional alternative. That's often a big difference.

Effects on Non-Energy Operations & Maintenance Cost

In addition to energy cost impacts, estimate the annual cost impacts of maintenance, repair, and replacement, if any. This O&M cost estimate must be based on a comparison of the new and base-case alternative (or replaced) products, including effects of reliability and service life.

Energy and Demand Savings Potential

Per unit, what are the kW and kWh savings for this product relative to the most realistic (future) competition? What is the value of this savings, under the most appropriate expected utility rate schedules? This should be done separately for each major application scenario and is the basis for the whole product justification.

Although this is a California-funded program, in most cases the products will be sold elsewhere as well. Both California and regional or national savings estimates are needed.

Non-Energy Benefits to Consumer

If applicable, list the non-energy benefits that may have value to the user, such as retail sales, safety, or worker productivity improvements. Estimate the value of the benefits, if possible, as these savings may be very important for some markets and products, and may be the key to a successful marketing strategy.

Societal Avoided Costs (for possible incentive payments)

What are the societal energy-related Avoided Cost benefits of this product for California? Estimate the costs, if possible. This calculation uses the CPUC Avoided Cost table (Appendix II), which includes marginal generation, distribution, and

environmental-externality cost estimates. This is the basis for possible utility incentive payments, which vary by situation. For some products, such as those providing primarily peak-demand savings, the CPUC method may not suffice.

Payback Period and Return on Investment

Unless there is a strong case for a longer payback term, we recommend use of a 2 ½ year payback criterion. This is based on widespread conventional practice. For some markets, a 10- or 15-year ROI is obviously more dramatic and may be persuasive in some cases, as suggested by ENERGY STAR. However, this does not seem to be commonly applicable because it implies a greater risk of stranded investment if the building is sold or reconfigured anytime during that period. Most building owners resist such risks and demand short paybacks on building-related upgrades like most high-efficiency lighting products.

The Bottom Line: Net Economic Benefit

What is the net economic benefit to the customer? This is a compilation of the above information. Calculate for both new and retrofit cases, if appropriate. This yields a maximum possible price for the manufacturer's product, which may or may not provide an adequate margin over the estimated actual cost.

Sales and Energy Savings Volumes

From the above and the following section's analysis of target market size, estimate the total potential unit sales. Also, report the total potential statewide and regional/national energy and demand savings.

3. Market Analysis

Market Segmentation, Size and Price Effects

There may be a variety of markets for some LRP products, with increasingly large total sales (and energy savings) at progressively lower prices. If applicable for this product, estimate the market segmentation and sizes for different product price points (graph or table). Consider California, regional, and national or international markets separately as appropriate. Compared against your best estimates of product costs and required margins, how does the price affect the total market size? Could efforts to reduce the product's price significantly increase its market?

Market Size versus Annual Sales

Obviously not everyone in the estimated target market will buy the product. Provide your reasoning on how the market size translates into an annual sales trajectory over at least the first few years. Also estimate the eventual sales based on likely total penetration rate.

The Buyer and Other Influencers

Who makes the buying decision for this type of product? Who are the other major influencers?

The Competition

What are the principal competing products, and how does this product have an advantage over that competition? How entrenched is the competition and what are its advantages that must be overcome?

Uncertainties

Identify intangible factors such as new-technology risk, warranty protection, buyer support, etc., that could affect the buyer's perception of value.

Consumer Choice Barriers

For this product, what are the principal issues for the buyer and key influencers? (some possibilities: initial cost, O&M costs, energy savings, non-energy features, competition, availability, visibility in market, reliability, longevity, warranty, ease of specification, liability).

4. Current Product Development Status and Needs

Product Development Status

What is the current state of this product's development? Where will it be at the end of this project?

Remaining Steps to Market Readiness

What remains to be done before it is market-ready? Describe briefly.

Codes and Standards

Do the product's energy saving and cost advantages depend on any current or scheduled code requirements? Are these code requirements likely to change? Conversely, are any new code requirements needed to encourage the adoption of this product? What needs to be done to promote those requirements, by whom, and are there any critical time deadlines?

Manufacturing Commitments

Who will initially produce and market this product? How firm is their commitment? If there is no current manufacturing partner, what steps have been taken to find one? (see next section for planning to do this, if needed)

Support to Manufacturer

What are the crucial criteria to assure the manufacturing partner's continued commitment? What are <u>you</u> committed to do to get an interested or involved

manufacturer to go all the way to production of this product? What else must others do?

Timing of Market Introduction

How soon is the manufacturer likely to introduce this product to the market, after production engineering, costing, tooling, initial production, and distribution and marketing arrangements? What is the expected rollout strategy, if known?

5. Technology Transfer Actions

For each of the following paragraphs keep in mind these guidelines: What activities are planned for completing during the LRP contract? After the contract? Who is responsible for completing these tasks? Please also provide a schedule of these activities.

Manufacturer Commitment

Describe how manufacturers will be found for the product. How will they be identified and approached? If known, who are prime candidates? What will be done to encourage their commitment, and by whom? For instance, how will this plan's proposed business case be used? Can other influencers help in convincing manufacturers? Who and how—and who will approach them and how?

Purchase Incentives

(Refer back to Business Case section for basic cost data) Are rebates or other incentives required to make this product competitive? These include direct incentives as well as mandated codes and industry standards. What is the plan for proposing and achieving such incentives? Who will lead this effort, and how? What timing is possible?

Educating Lighting Designers and Specifiers

What efforts in product introduction are needed to promote awareness and understanding among lighting applications specifiers? Who will be doing it? What type of material (early case-study applications, journal articles, conference presentations, spec sheets, brochures, press announcements, trade ads, education for manufacturing reps and distributors, trade show exhibits, etc.) is needed?

Other Intermediaries

Who might hold up or advance the success of this product? Are there influential actors who must be encouraged? These might include distributors, manufacturers' agents, and local building code enforcers, for example. For this product, how important are these efforts, how will they be done, and by whom?

Tools: Design and Specification Aids

Are design and specification aids needed, such as computerized or written guides for sizing and energy-cost savings calculations? If so, what is needed and who should

develop it for this product? What is it likely to cost, and is this viable? (Note that this information will be helpful in focusing the LRP's own project on design tools.)

Media: Papers, Presentations and Press Releases

What specific papers, presentations and press releases are needed? Describe the overall media approach. List event names and dates to the extent possible.

Other Outreach Actions

What other outreach efforts are needed to speed market adoption? Additional field demonstrations? Implementation of code changes? (etc.)

(continue for economic analysis guidelines)

Appendix I: Simplified Economic Analysis for Tech Transfer Plans

Using this Analysis Guide

The instructions included here explain an accompanying Excel spreadsheet template, so you can either dive right into the spreadsheet, using this explanation only as a reference, or work your way through this extended description of its functionality first. The ultimate result will be an assessment of your product's business case.

Included in the Excel worksheet are two sample analyses, one for Project 4.1, the Motion Sensor Nightlight and the other for Project 5.1, the Bi-level Stairwell Fixture. We hope that these two examples will provide some guidance in supplying data for your project. We will also use data from these examples to help explain the instructions.

A more complex analysis spreadsheet is also available, involving explicit consideration of alternative utility rate structures with various types of hourly or peak-demand charges. Products that have especially high potential for reducing energy usage disproportionately during peak periods may find an improved business case using that approach. However, our analysis indicates that in most cases this complexity will not make a significant difference in the results.

Making the Business Case

The business case is based primarily on the relationship between the cost of the product and the energy saved as compared to a less energy efficient or more expensive conventional alternative that is currently available in the market. Determining the characteristics of the conventional alternatives is essential to determining the success of the business case.

Scenario Building

A good approach to making the business case is to define a number of different scenarios that will allow you to compare each set of assumptions. The first column in the Excel sheet has been subdivided into two scenarios based on different utility district types: Investor-owned Utility Districts and Municipal Utility Districts. The current pricing gap between the MUDs and IOUs will significantly affect the payback calculations; therefore you should have the same product scenarios included separately for each environment.

Utility Energy Price Differences

Column B — Customer Electricity Rate

Currently, prices in California IOUs are much higher (over 50% higher) than those in MUDs.

Small Commercial Average Electricity Rates in cents per kWh ($2001)

Year	PG&E	SCE	SDG&E	LADWP	SMUD

2002	16.72	18.13	17.14	10.69	10.11
2003	16.44	17.81	17.02	10.55	9.97
2004	13.59	15.35	14.90	10.33	9.71
2005	12.88	14.75	14.84	10.24	9.65
2006	14.27	14.37	14.91	10.36	9.67
2007	13.94	14.02	14.49	10.52	9.73
2008	13.05	12.79	13.54	10.79	9.84
2009	12.82	12.49	13.31	11.04	9.94
2010	11.70	12.28	13.08	11.25	10.02
2011	11.64	11.63	12.27	11.50	10.13
2012	11.59	11.53	12.15	11.80	10.23

To determine a standard customer electricity rate in the spreadsheet, we calculated ten-year averages for both the investor-owned utilities and the municipal utility districts. Then we averaged this across both utility types. Obviously it would be possible to make an even better case by using the short-term numbers (which are higher) for a short-term payback, but by using a ten-year average we have a more realistic estimate of the success of the projects going forward.

Ten-Year Average Cost of kWhr (¢2001)

	PG&E	SCE	SDG&E	LADWP	SMUD
10-Year Averages	14.8¢	16.0	15.8	10.4	9.8
Utility-Type Averages	**15.5¢**			**10.1¢**	

Competing Alternatives

Most likely, your product will not be competing against a single existing product, but rather a variety of alternative technologies already in use. The current population of installed lighting technologies is very broad and while there are not definitive surveys of what exists for most specific applications, having some understanding of the alternatives is essential to understanding the pathway for further product development. Below are two examples of the scenarios chosen for Projects 4.1 and 5.1, representing both retrofit and new construction options.

Scenarios for Project 4.1 (nightlight)

Fixtures: *watts per fixture*

Overhead Lights

Incandescent (75W)	75
Two-Lamp T8 Fluorescent (62W)	62
One-Lamp T8 Fluorescent (32W)	32

Vanity Lights (4 bulbs)

Incandescent (60W)	240
Fluorescent (20W)	80
Incandescent Globe (40W)	160
Fluorescent Globe (15W)	60

Scenarios for Project 5.1 (stairwell)

Fixtures *watts per fixture*

2-lamp 4-foot T12	90
1-lamp 4-foot T12	50
2-lamp 4-foot T8	62
1-lamp 4-foot T8	32
Circline T9	22

For each scenario, you will need to define a number of other variables to establish the standard against which your product will compete.

Column C — Base Cost of Alternative Conventional Technology

In an ideal scenario, the cost of the new LRP product would be no more than the technology it competes against; thus the added feature of energy savings would make the new technology an uncontested winner when compared to the conventional alternative(s). This is rarely the case. Therefore in new construction, the energy savings will be matched against the difference in cost between the new technology and the most appropriate existing alternatives.

Column D — Base Watts Used at Full Power

How many watts does this existing alternative product use in its normal operating mode? Does it run at full power, or does the technology have some reduced level (dimming, etc.)? To simplify the analysis, the spreadsheet example assumes that the existing fixture functions normally at full power, but the spreadsheet can be adjusted to accommodate more complex operations.

Column E — Hours per Day at Full Power

How many hours is the fixture on in its normal mode in an average day? Since we will deal with days of use separately, you should consider the average day when the fixture is actually in use. In this simplified analysis, we assume no time-of use rate differences. We have performed more complicated analyses that recognize possible savings or additional costs related to time of use (i.e. breaking up the day into peak, part-peak and off-peak hours) and a "time of use" spreadsheet is available for project managers interested in performing a more complex analysis. "Time of use" calculations were done for Projects 4.1 and 5.1 and the resulting savings differed by only 0%-10% from the simpler calculations, depending on the specifics of the scenario.

Column F — Days per Year the Fixture is used

Here you should subtract days when the fixture will not be used at all. For the motion sensor nightlight, we reduced the number of days by the expected occupancy rate to estimate occupied days—the only days when the bathroom light would be used. In other cases, the lights in question might not be used during the summer, or on weekends and holidays. To get an accurate idea of how much energy is currently in use by the existing alternative lighting solutions, we need to eliminate these non-use days from the calculations.

New Technology Costs

For a new product, the cost includes the product's net installed cost plus other O&M cost differences. There are special considerations for new versus retrofit applications that are detailed below.

Column G — Cost of New Technology

This business case analysis will yield a maximum price for the product to satisfy the user's criteria (which we call the *optimal cost*) in a later calculation. However, it is useful to estimate what the product might cost when introduced into the market even before knowing the optimal cost. If the product is already available (as it was in the case for the nightlight and the stairwell fixture) determining this price is much easier. For products not quite as far along in development, an estimate of the final delivered product price should be developed based on the manufacturer's expected costs (materials, processing, packaging, margins, marketing, shipment, and reserves for distributor and customer support) plus other supply-chain costs and margins.

Column H — Expected Life of New Fixture

Once installed, it is expected that some amount of time might pass before a certain product will be replaced. This is not necessarily the life of the product per se, but how long the product might reasonably be expected to remain in use before getting replaced. This number will be used to determine the total avoided costs of energy over the life of the fixture, which will help in justifying an incentive.

Column I — New Fixture Watts at Full Power

How many watts does the new technology use in normal operating mode? This should be readily available.

Column J — Time at Full Power

This is measured as a percentage of the existing base-case operating hours. There might be no reduction in usage (instead simply a reduction in watts) or there might be only a change in time at full power (as in the case of an occupancy sensor) or a change in both time and watts (as in the case of the bi-level stair fixture).

Column K – Minimum Power Watts

This is a measure of wattage that might be used in a secondary operating mode (especially in bi-level or dimming products, but also possibly in other instances such as turned off).

Column L **–** Time at Minimum **Power**

This is measured also as a percentage of the existing base case and in many instances is the remaining percentage of the time at full power (i.e., Time at Full Power + Time at Min Power = 100%), although it is possible that the minimum power and the full power will be separate sources that could be on at the same time.

Retrofit vs. New Applications

Column M — Change Labor Cost for New Construction

In some instances, there is a difference in the labor cost between the new application and the conventional alternative. This needs to be included in the cost calculations (in some cases, it might even be simpler to install the energy efficient alternative in which case, there would be a labor savings).

Column N — Labor Cost for Retrofit Application

For retrofits, there is almost always an additional labor cost for removing the old equipment and installing the new technology, including commissioning adjustments if needed.

Other Assumptions

Column S — Net Present Value of Societal Avoided Costs

A second worksheet in the Excel spreadsheet includes a CPUC table on avoided costs. Based on the number that you use in the fixture life column, choose the appropriate avoided cost amount. This will be multiplied by the kWhrs saved to give the present value of the kWhrs. This will be the basis for most incentive calculations. The avoided costs include the utility costs as well as externalities. This is an upper limit for incentive program costs.

Results

Savings Calculations

We derive the Average Reduced Watts (Column O) by adding the Full Watts (Column I x Column J) to the Minimum Watts (Column K x Column L). Average kW Saved (Column P) equals the Standard Technology Base Watts minus the Average Reduced Watts divided by 1000. The Yearly Savings calculation (Column R) is found by multiplying the kWhrs saved per year by the price of electricity. The Yearly Savings calculation is the basis for the whole product justification.

Avoided Costs

Avoided (societal) costs are calculated by using the expected life of the new fixture to determine what the CPUC would calculate as the net present value of the avoided costs. This amount is then multiplied by the kWh saved per year (Column Q), yielding the total Avoided Cost, which the utilities would use to determine the maximum size of a societally justifiable rebate.

Direct Payback versus Return on Investment

Simple Direct Payback is a standard used to judge the viability of energy efficiency products by determining how long (in years) it will take to earn back the money invested in the upgrade and to thereafter start actually earning money on the investment. If we were to assume energy cost savings as an absolute good, then we would merely need to break even on our investment (after adjusting for some sensible discount rate). This is basically the calculation done in determining the net present value of avoided costs. If the price of the product is less than the net present value of avoided costs, then the product is unlikely to be viable unless it has major non-energy benefits.

Most building owners do not seem to see energy efficiency as an absolute good and won't invest in it unless they believe that they will be able to recoup their investment and make a little money as well. The payback terms most owners demand currently seem to cluster around 2.5 years. This may seem overly conservative, but is actually quite rational. It avoids the risk of having their energy efficiency investment fail to pay back fully or gain an adequate return in case they sell the building before the full lifetime of the efficiency improvement. This is very important even to many long-term

owners who want to keep their options open, especially since remaining energy efficiency cost savings are unlikely to be capitalized in a sales price.

A 2.5-year payback represents approximately a 38% return on investment over an approximate 15-year product life. Since there is a variety of risks involved in these investments (for instance, not really having a good handle on either the future cost of electricity, the future usage patterns in the building where the lighting technology has been installed, or the stranded investment-risk concern) this theoretical ROI is often greatly discounted in practice. In any case, anything less than a 2.5 year payback should be a simple sell, while a longer term will either require more creative methods to convince the typical building owner or a narrower focus on buildings with owners less sensitive to these risks, such as government agencies. We recommend simple payback for most LRP products. For situations in which ROI may be useful, refer to the EPA ENERGY STAR web site for a particularly elegant rationale and methodology.

Simple Direct Payback Calculation

$$\text{Simple Payback Time} = \frac{\text{Net Increase in Capital Cost}}{\text{Net Savings in Operating Cost}}$$

The Increase in Capital Cost is different for new and retrofit applications. In new applications you can subtract the base cost of the standard technology (since it is assumed that this would be otherwise spent) and you must add or subtract any change in the labor costs for installation. In Retrofit Applications, there is no standard technology base cost to subtract (since it is assumed that no retrofit would occur otherwise) and you must add the full labor costs of a retrofit plus the disposal cost of the existing technology.

Determining the "Optimal Cost"

The Optimal Cost is the product's maximum viable net price to the user. This is determined by the calculated net yearly savings multiplied by the user's payback term criterion (we are assuming 2.5 years)…plus the Capital Cost adjustments as noted above. The Optimal Cost then represents the buyer's ceiling price (for the product, exclusive of installation) beyond which it will begin to be difficult for manufacturers to sell the product without making a convincing case for additional non-energy benefits that the product might provide.

Using the Optimal Cost, the spreadsheet computes the Cost Gap. The Cost Gap equals the New Technology Base Cost minus the Optimal Cost—that is, the amount by which the product's actual estimated cost-based price exceeds the amount that the user is likely to be willing to pay for it. If no New Technology Base Cost is known, then production of the new technology should proceed with the Optimal Cost used as the manufacturer's cost target.

If the Cost Gap is positive (and it almost always is with new technologies) then the developer will need to find some way to sell the product other that simply an energy savings direct payback.

There are several ways to "Close the Gap" either singly or in combination:

1. Federal/State rebate or other incentive payment

2. Cost reduction due to economies of increased sales volume

3. Innovation or product simplification

4. Emphasis on externalities (non-energy benefits)

a. Green benefits

b. Productivity benefits

Making Sense of the Data

You can think of each scenario as a different sub-market—for instance, hotel rooms with 240W of bathroom lighting that could be controlled by an occupancy-sensing switch and nightlight. Once you have completed calculations for a few market scenarios, based on your market research or assumptions, you will have a better understanding of how your product will perform in a variety of different sub-markets. For each such scenario, the spreadsheet's calculated Cost Gap indicates the size of other benefits or cost offsets that must be found, if needed. An adequate utility incentive may be justified by the Avoided Cost entered earlier in the spreadsheet, and/or the product may have non-energy benefits valued enough by the buyer. But one way or another, the cost gap must be closed.

This economic analysis plus your market assessment (or assumptions) may indicate that the viable market for your product is narrower or more scattered than would make the product worth pursuing as currently designed. If so, this economic analysis will help you to gauge how much more energy would need to be saved, what new features might be added, or how much cheaper the product would have to be to meet the needs of larger markets—i.e., more of the application scenarios you had defined. If the size of the market is large enough to support manufacturing the product, it is possible that no additional changes will need to be made, but you will still be able to focus the marketing campaign for the product.

Appendix II: CPUC Avoided Cost Table

The attached table was developed by the CPUC to estimate the energy-related ***societal*** *benefits of California energy efficiency products and programs. Its main use is to establish a ceiling for public investment (rebates, etc.) in support of a product or program; it is NOT for use in estimating the user's costs and savings. This table presents statewide average avoided cost estimates; more location-specific results could be provided but are generally unnecessary.*

Note that no separate kW peak-demand savings are included in these estimates; instead, the CPUC's rationale is that since they are using projected spot-market electricity prices, those prices bear at least a seasonal and diurnal-historical relationship to future demand premiums. In some instances this may cause underestimation of a product's value, but is a reasonable standard initial approach.

In extreme cases the product developer may wish to add comments and further demand-related value estimates.

(Source: Eli Kollman, Energy Efficiency Division, CPUC-SF)

								Discount Rate				
			AVOIDED COST VALUES						8.15%			
	Electric					Natural Gas						
Statewide Avg.	**Gen**	**T&D**	**Env.Ext.**	**Total**			**Gen**	**T&D**	**Env.Ext.**	**Total**		
Year	**$/kWh**	**$/kWh**	**$/kWh**	**$/kWh**		**Year**	**$/thm**	**$/thm**	**$/thm**	**$/thm**		
2002	0.09905	0.00525	0.00655	$0.11		**2002**	$0.49	$0.03	$0.06	$0.58		
2003	0.05671	0.0055	0.0068	$0.07		**2003**	$0.37	$0.03	$0.06	$0.46		
2004	0.05341	0.00574	0.00704	$0.07		**2004**	$0.34	$0.03	$0.06	$0.43		
2005	0.05451	0.006	0.0072	$0.07		**2005**	$0.35	$0.03	$0.06	$0.44		
2006	0.04961	0.0062	0.0074	$0.06		**2006**	$0.37	$0.03	$0.07	$0.47		
2007	0.05155	0.0065	0.0076	$0.07		**2007**	$0.39	$0.03	$0.07	$0.49		
2008	0.05325	0.00675	0.00785	$0.07		**2008**	$0.40	$0.04	$0.07	$0.51		
2009	0.0551	0.00704	0.00814	$0.07		**2009**	$0.42	$0.04	$0.07	$0.53		
2010	0.05708	0.00734	0.00834	$0.07		**2010**	$0.44	$0.04	$0.07	$0.55		
2011	0.05896	0.0076	0.0086	$0.08		**2011**	$0.38	$0.04	$0.08	$0.50		
2012	0.06138	0.00794	0.00884	$0.08		**2012**	$0.40	$0.04	$0.08	$0.52		
2013	0.06399	0.0083	0.0091	$0.08		**2013**	$0.42	$0.04	$0.08	$0.54		
2014	0.06676	0.0086	0.0094	$0.08		**2014**	$0.43	$0.04	$0.08	$0.55		
2015	0.06976	0.009	0.0097	$0.09		**2015**	$0.45	$0.04	$0.09	$0.58		
2016	0.073	0.00934	0.00994	$0.09		**2016**	$0.48	$0.04	$0.09	$0.61		
2017	0.07649	0.00974	0.01024	$0.10		**2017**	$0.50	$0.04	$0.09	$0.63		
2018	0.08023	0.01014	0.01054	$0.10		**2018**	$0.52	$0.05	$0.09	$0.66		
2019	0.08428	0.01055	0.01081	$0.11		**2019**	$0.54	$0.05	$0.10	$0.69		
2020	0.08844	0.01059	0.01108	$0.11		**2020**	$0.57	$0.05	$0.10	$0.72		
2021	0.09287	0.01112	0.01136	$0.12		**2021**	$0.59	$0.05	$0.10	$0.74		
SUM	$1.35	$0.16	$0.18	$1.68		**SUM**	$8.85	$0.66	$1.57	$11.20		
				$0.00						$0.00		
PV (1 yr)	$0.10	$0.01	$0.01	$0.11		**PV (1 yr)**	$0.49	$0.03	$0.06	$0.58		
PV (2 yr)	$0.15	$0.01	$0.01	$0.17		**PV (2 yr)**	$0.83	$0.06	$0.12	$1.01		
PV (3 yr)	$0.20	$0.02	$0.02	$0.23		**PV (3 yr)**	$1.12	$0.08	$0.17	$1.37	Discount Rate	8.15%
PV (4 yr)	$0.24	$0.02	$0.02	$0.28		**PV (4 yr)**	$1.40	$0.11	$0.21	$1.72		
PV (5 yr)	$0.28	$0.02	$0.03	$0.33		**PV (5 yr)**	$1.67	$0.13	$0.27	$2.06		
PV (6 yr)	$0.31	$0.03	$0.04	$0.38		**PV (6 yr)**	$1.93	$0.15	$0.31	$2.40		
PV (7 yr)	$0.34	$0.03	$0.04	$0.42		**PV (7 yr)**	$2.18	$0.17	$0.36	$2.71		
PV (8 yr)	$0.38	$0.04	$0.04	$0.46		**PV (8 yr)**	$2.43	$0.20	$0.40	$3.02		
PV (9 yr)	$0.41	$0.04	$0.05	$0.50		**PV (9 yr)**	$2.66	$0.22	$0.43	$3.31		
PV (10 yr)	$0.44	$0.04	$0.05	$0.53		**PV (10 yr)**	$2.85	$0.24	$0.47	$3.56		
PV (11 yr)	$0.46	$0.05	$0.06	$0.57		**PV (11 yr)**	$3.03	$0.26	$0.51	$3.80		
PV (12 yr)	$0.49	$0.05	$0.06	$0.60		**PV (12 yr)**	$3.21	$0.27	$0.54	$4.03		
PV (13 yr)	$0.52	$0.06	$0.06	$0.64		**PV (13 yr)**	$3.38	$0.29	$0.58	$4.24		
PV (14 yr)	$0.54	$0.06	$0.07	$0.67		**PV (14 yr)**	$3.54	$0.30	$0.61	$4.45		
PV (15 yr)	$0.57	$0.06	$0.07	$0.70		**PV (15 yr)**	$3.70	$0.32	$0.64	$4.65		
PV (16 yr)	$0.59	$0.06	$0.07	$0.73		**PV (16 yr)**	$3.85	$0.33	$0.67	$4.85		
PV (17 yr)	$0.61	$0.07	$0.08	$0.76		**PV (17 yr)**	$4.00	$0.34	$0.69	$5.04		
PV (18 yr)	$0.64	$0.07	$0.08	$0.79		**PV (18 yr)**	$4.15	$0.36	$0.72	$5.22		
PV (19 yr)	$0.66	$0.07	$0.08	$0.81		**PV (19 yr)**	$4.28	$0.37	$0.74	$5.40		
PV (20 yr)	$0.68	$0.08	$0.09	$0.84		**PV (20 yr)**	$4.42	$0.38	$0.76	$5.56		

Appendix D: Sample Press Release

ARCHITECTURAL ENERGY
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FOR IMMEDIATE RELEASE

October 14, 2004

California-Sponsored Innovations in Lighting Technology Showcased

Several important new lighting products sponsored by the California Energy Commission were presented at today's *Emerging Technologies in Energy Efficiency Summit* in San Francisco.

A bathroom light switch incorporating an occupancy sensor and an LED nightlight is now available from the Energy Commission's Lighting Research Program participant The Watt Stopper, Inc. Intended for hotel and institutional use, this light switch is easily installed in a standard single-gang wall switchbox. Field tests demonstrated major energy savings and a positive response from both hotel managers and occupants.

LaMar Lighting showed their new commercial building stairwell light fixture that saves energy by reducing the lighting levels in stairwells when unoccupied. This fixture responds to new national lighting standards, which may raise the required lighting level in occupied stairwells in California. A lower minimum level may still be required at all other times. This product is particularly well suited to the many high/mid-rise buildings with emergency-only access to stairwells.

A fully integrated classroom lighting system was displayed by the Energy Commission's program participant Finelite, Inc. This system uses new reflective material and fixture designs to offer increased energy efficiency, while providing a single-source warranty for all components. Several levels of functionality are offered for both new construction and retrofit uses.

Other LRP lighting products now entering the market include new ENERGY STAR® qualified pin-based CFL table lamps for both residential and institutional use. Four manufacturers participated in the Energy Commission program, including American Fluorescent, Fire & Water, MaxLite, and PowerLux. The new lamps cover a spectrum of features, styles, and costs.

Under the LRP, the "SPOT" computer software for simplifying daylight sensor placement was developed by Architectural Energy Corporation and is now available for beta testing. The Program also funded the development of an enhanced control protocol for the Digital Addressable Lighting Interface (DALI) system. This open protocol's provisions give designers new lighting network capabilities and the use of components from different manufacturers.

The LRP also supported R&D on a broader range of future technologies, including some to reach the market in 2005-06. The California Lighting Technologies Center at UC-Davis demonstrated several innovations such as an easy-to-install CFL recessed ceiling downlight system for use in residential and commercial buildings and various configurations for LED enhanced exterior and bathroom fixtures. Lawrence Berkeley National Laboratory, another LRP participant, contributed innovative efforts on LED configurations for task lighting, low-glare outdoor fixtures, and an integrated system to bring low-cost lighting control to existing commercial buildings. Still other R&D project participants focused on LED-based elevator lighting, improved classroom photosensors, and load-shedding ballasts.

The Summit event was sponsored by the California Investor-Owned Utilities, the California Energy Commission, and the American Council for an Energy Efficient Economy. The Summit brings together a diverse audience of policy makers, program planners and implementers, researchers, technology developers, financiers, manufacturers and end users to discuss the latest innovations in energy-efficient technologies and practices.

The Lighting Research Program is part of the California Energy Commission's PIER (Public Interest Energy Research) Buildings program, which seeks to improve energy efficiency in new and existing California buildings through innovations in technology and practice. The LRP is a two-year $5.2 million R&D program, now nearly completed, includes a variety of technology developers and facilitators working together to develop and commercialize a broad range of advanced lighting innovations. Most LRP technology innovation projects include a cofunding commercial manufacturer in order to assure practicality. The lighting industry is also represented on the LRP's advisory committees. All R&D results are non-proprietary and available to all commercial lighting producers.

Further Information: www.archenergy.com/lrp or Judie Porter at Architectural Energy Corporation, 303.444.4149.

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Appendix E: Product Summary Sheet

Lighting Research Program Products

Public Interest Energy Research

The goal of the California Energy Commission's PIER Lighting Research Program (LRP) is to create new lighting technology and products that can save energy, reduce peak demand, and reduce pollution for the citizens of California. The LRP includes fifteen research projects spanning both the residential and commercial sectors as well as outdoor lighting associated with buildings, and three market connection projects.

Products Available for Specification

LED Occupancy Sensor and Bathroom Smart Fixture

Concept: An LED occupancy sensor that can be installed in a half hour or less and serves the dual purpose of lighting control and night lighting for hotel bathrooms. Concept development for a smart bathroom fixture is also planned.

Solution: The Watt Stopper's Motion Sensor Nightlight is the first implementation of this concept. PIER helped fund a demonstration at the Sacramento DoubleTree Hotel with support from the Sacramento Municipal Utility District (SMUD). The resulting data indicated that the nightlight provided 46 percent energy savings. The California Lighting Technology Center (CLTC) is also working with Lithonia and SMUD on development of a bathroom smart fixture. Demonstrations of the fixture in hotel and assisted living applications are underway.

Bi-level Stairwell Fixture

Concept: A bi-level fixture for stairwells that maintains a low light level, switching to full light output only when occupancy is detected. This product is designed for stairwells, restrooms, laundry rooms, and other areas that demand minimal but constant lighting over long periods of time.

Solution: LaMar Lighting's bi-level stairwell fixture has an integrated occupancy sensor and saves energy by operating most of the time at a low standby light level. Results from four PIER-funded demonstrations, which included three office buildings and a university building in California, indicate energy savings of 40 to 60 percent for stairwell lighting.

Integrated Classroom Lighting System

Concept: A complete lighting system that simplifies the requisition process for schools trying to meet high energy performance standards by providing direct-indirect fixtures, occupancy and daylight sensors, and plug-and-play interconnection cables.

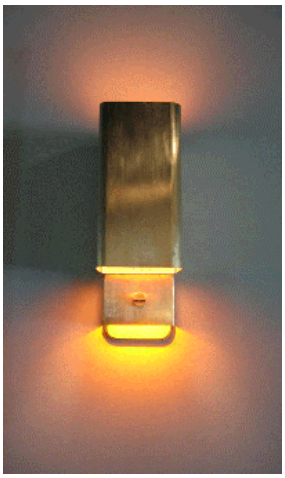
Solution: PIER's manufacturing partner, Finelite, Inc., coats their direct/indirect fixtures with 96% reflective white paint, allowing for either two or three rows of fixtures. With the Integrated Classroom Lighting System, schools receive premium lighting and controls for less than the cost of standard 2x4 lay-in fixtures. Nineteen demonstration classrooms have shown energy savings of 30 to 50 percent over current Title 24 levels. A secondary project is underway with Southern California Edison (SCE) and The Watt Stopper to develop and recommend a system for the Los Angeles United School District.

ENERGY STAR® Residential Light Fixtures

Concept: Based on data gathered at a series of EPA workshops, PIER is encouraging lighting manufacturers to develop high-end, portable indoor residential fixtures. These fixtures will utilize pin-based CFLs rather than screw-in bulbs, and will qualify for the ENERGY STAR label.

Solution: Four lighting manufacturers — American Fluorescent, Fire & Water, MaxLite, and PowerLux — have developed pin-based CFL portable residential fixtures with electronic ballast that meet ENERGY STAR specifications and provide high-quality lighting. These fixtures will be available in the California marketplace by the end of 2004. Energy savings vary ranging from 50 to 75 percent over a typical 120-watt incandescent fixture.

Products Available for Demonstration



LED Exterior Luminaire

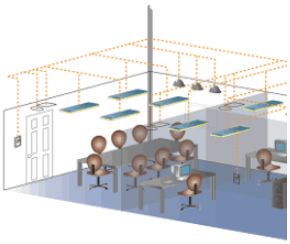
Concept: The objective is to work with one or more manufacturing partners to design, prototype, and evaluate a series of exterior porch lighting systems that integrate high efficiency optics with solid state technology and lighting controls into one system.

Solution: The CLTC has developed a series of designs for various exterior applications. The main concept is a hybrid approach to LED illumination. It combines an 'always on' ambient LED illuminator with a standard incandescent lamp on a motion control sensor.

Energy use is reduced from 60 watts for a typical incandescent lamp to 5 watts for the LED package. CFL options may be developed. A demonstration is underway. Three manufacturing partners (Shaper Lighting, The Watt Stopper, and Lithonia Lighting) are working with the CLTC on various fixture concepts.

DALI Control Standards

Concept: The objective is to develop an open controls standard to allow for a complete DALI-managed lighting system. The enhanced DALI standard will enable the control devices of different manufacturers to operate on the same control system.



Solution: PIER has brought together a NEMA-facilitated working group of major manufacturers to develop an open standard for controls. This process included gaining input from designer and end-user groups. Some of the participants in the standard development include Advance, Genlyte, Leviton, Lutron, Starfield, Universal Ltd., and The Watt Stopper. A demonstration of the new control standard is underway at two of The Watt Stopper's facilities. NEMA anticipates adopting the standard by 2005.

Retrofit Fluorescent Downlights

Concept: The objective is to develop an easy-to-install compact fluorescent downlight system for use in existing commercial and residential applications.

Solution: Working in close partnership with Lithonia Lighting, the CLTC is developing a simple retrofit strategy for fluorescent downlights with flexible optical head mounting, 2-lamp ballast, low glare reflector optics, and plug-n-play wiring. A new construction version of the product is in production with units currently being installed by a number of Sacramento homebuilders. Energy use of the new construction system is approximately one-third of incandescent. The retrofit product, which will be applicable for residential and commercial installations, is expected to be ready by 2006.

Sensor Placement Optimization Tool

Concept: The goal is to develop software tools that take advantage of the PIER LRP products and technologies or fill a need in the lighting community for a specialized tool.

Solution: The Sensor Placement Optimization Tool (SPOT) is a software package intended to assist a designer in establishing the correct photosensor placement relative to the daylighting and electric lighting. SPOT consists of an Excel interface on top of a Radiance calculation engine that provides information regarding photosensor selection, placement, and performance. SPOT was developed by Architectural Energy Corporation with classroom daylighting in mind, but may be applied to other spaces.

Other LRP Products Under Development

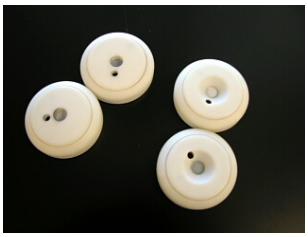
LED Low Profile Fixtures

Concept: A low-profile LED luminaire that will take advantage of the benefits of solid state lighting. This fixture would be suitable for applications where operating hours are long, space is limited, and reduced maintenance is desired.

Solution: The Lighting Research Center (LRC) has developed prototype fixtures for elevators. A demonstration of the fixture prototype is underway at the Rensselaer Polytechnic Institute campus. Currently, LRC is courting manufacturers to bring the

product into production. Preliminary information on jewelry case applications is also under development.

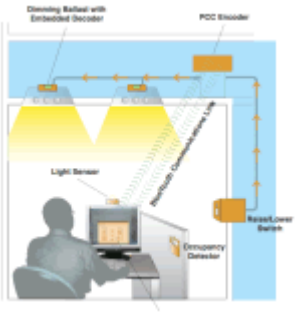
Improved Classroom Photosensor



Concept: An improved daylight responsive lighting control for classrooms with an expanded cone of view. The photosensor will be easy to calibrate with a simple hand held tool reusable for multiple installations.

Solution: The Watt Stopper is working to improve their current photosensor design using the PIER-funded performance specification developed through a lengthy process of reviewing existing products, consulting with industry experts, and evaluating computer simulations. The hand held calibration tool simplifies commissioning. A small-scale classroom demonstration at SCE has been completed. Product release is planned for 2005/ 2006.

Integrated Lighting Control System



Concept: An advanced lighting controller designed to bring low-cost control to existing lighting systems in commercial buildings. The specific hardware is designed to work with commercially available fluorescent lighting ballasts to form the core of a highly progressive, functional and efficient lighting control system.

Solution: LBNL researchers collaborated with Vistron to create a proof-of-concept dimmable lighting control system that does not require additional control wiring in the ceiling. The system uses a new power line control communication technology, called Phase Cut Carrier, to send digital commands over existing lighting power circuits. LBNL is communicating with various manufacturing partners about producing the different components of the system.

LED Task Light

Concept: A high performance task light that uses state-of-the-art LED and thermal management technology.

Solution: Lawrence Berkeley National Laboratory (LBNL) has assembled four manufacturers to develop the product. Permlight is prototyping the thermal management assembly board. Advanced Transformer is making the necessary ballast with variable intensity. Cree Lighting is providing the LEDs. Luxo is the luminaire manufacturer, developing designs to meet both the US and European markets. Comparing an 18-watt CFL, the LED task light uses a 10-watt LED package and provides quality optics.

The Portable Office Lighting System

Concept: A floor-standing fixture with user and space management controls that separately adjusts ambient and task lighting. Optional office-level controls will provide easily choreographed motion/occupancy sensors and monitor usage in a modular way.

Solution: The CLTC and LBNL are currently developing control strategies and prototypes of this system. Finelite, Inc. serves as the manufacturing and commercialization partner. Pacific Gas & Electric (PG&E), SCE, and SMUD have expressed interest in providing demonstration opportunities for the technology. The use of portable office lighting in lieu of overhead systems may reduce energy use up to 60

percent.

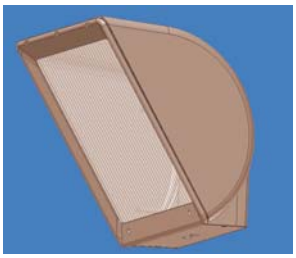
Load-shedding Ballast Technology

Concept: The load-shed ballast is designed to replace existing instant start ballasts in fluorescent lighting fixtures used in commercial buildings. When a signal is received via power line carrier communications, the load-shed ballast dims the fluorescent light fixture, reducing the lighting power by a fixed amount during periods of high electric demand.

Solution: The LRC is working with a major ballast manufacturer on integrating the load-shed design into an existing ballast case. In addition, they are surveying power line carrier communication systems to determine the most effective means to deliver the load-shed signal to the ballast. The LRC is also working with NYSERDA to demonstrate the technology in a commercial building in 2005.

Low Glare Outdoor Fixtures

Concept: Wall packs are common on commercial buildings for security and nighttime lighting. The objective is to replace wall packs with a cost competitive product having the following features: high efficiency, quality optical performance, and better light quality. The anticipated results are to reduce energy consumption and night light pollution.



Solution: LBNL is working with Gardco Lighting to model, develop, and evaluate a new concept luminaire, which features a ceramic metal halide lamp and a near full cut-off tilted lens. The Gardco luminaire will throw the light 45 feet when mounted at a height of 15 feet and potentially provide energy savings while illuminating more area than conventional wall packs.

HID Electronic Ballast Testing

Concept: The objectives are to test, analyze, and determine the potential of electronic ballasts for HID lighting systems in cooperation with manufacturers. Control strategies will be studied for commercial, industrial, and municipal applications. Also, appropriate recommendations may be developed for integrating this technology into current state codes.

Solution: The measurements to characterize the performance of HID lamp-ballast systems have been performed at LBNL. Both electrical and spectral performance measurements have been completed for low and high wattage systems. Control strategies are under evaluation. In related work, LBNL is also testing HPS electronic ballasts for the City of Oakland.

Market Connection Activities

Concept: The goals are to provide crosscutting market connection activities for the PIER LRP projects, while improving the market focus of the individual projects to make the products more commercially viable

Solution: Led by Bevilacqua Knight, the PIER team has worked together to create and implement a consistent and coordinated effort of market activities. Expert guidance has

been solicited and provided to project leads, and alliances have been developed with key professional, governmental, and trade organizations.

Codes and Standards

Concept: The goal of this project is to determine how the PIER Lighting Research Program can best translate its successes into workable code and standards proposals. The emphasis will be to identify efforts that are likely to have the largest energy savings and demand reduction potential.

Solution: Heschong Mahone Group has been evaluating all the LRP efforts, and mapping the path from each research and product outcome into the codes and standards arena. They have identified the most code-ready technologies and recommended steps to adoption, and identified those projects that may require additional R&D before they can enter the code process.

Detailed information on each of the PIER Lighting Research Program projects is publicly available on the following web sites: http://www.energy.ca.gov/pier/buildings/projects/500-01-041-0.html or http://www.archenergy.com/lrp.

Arnold Schwarzenegger, *Governor*
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