

**REDUCING BARRIERS TO USE OF
HIGH EFFICIENCY LIGHTING SYSTEMS:
TECHNOLOGY TRANSFER PLAN
Sponsor: US DOE**

May 27, 2003

I. OBJECTIVE

Develop a viable **technology transfer plan** to bring to market improved, integrated lighting and control systems that will be embraced by end users and will therefore significantly reduce energy used for lighting in commercial buildings.

II. FACTUAL INFORMATION

- The proposed Energy Policy Act, 2003, places renewed emphasis on load management and real time pricing. Lighting loads in commercial buildings are some of the easiest and best electric loads to control during periods of high electrical usage. Lighting control systems such as the load-shedding ballast, which are responsive to customer needs and cost-effective, will greatly enhance the ability of lighting to be used successfully for load management purposes.

Real time pricing will expose business customers to the actual high costs of electricity during times of peak electrical usage. This pricing will require customers to seek cost effective alternatives to reduce electric loads during these peak times. Lighting and its appropriate controls offer customers, regardless of size, the ability to control electric loads and, thereby, control costs.

- While most of the United States currently has sufficient electric generating and transmission capacity, there are pockets across the country where neither generation nor transmission are robust enough to provide electricity efficiently during periods of high demand. These areas include southwest Connecticut, New York City, Long Island, NY, major metropolitan areas of Texas and the Bonneville Power Administration (WA, ID, OR, MT) area. The BPA situation is somewhat unique in that it involves electric loads which peak in the winter. Areas in the northern US such as Idaho and Minnesota experience summer electric peaks of such short duration that generation and transmission alternatives are prohibitively expensive.

To ensure the security and availability of electricity in these pockets of electric capacity need and to overcome the growing problem of the “not in my back yard” syndrome of sighting generation or transmission assets, load management alternatives must be developed. Lighting and lighting controls offer a cost-effective, viable alternative that can be employed in the near future. Lighting controls such as load-shedding ballasts and the self-commissioning photosensor have the potential to reduce lighting loads by 30% in all types and sizes of businesses when the demand for electricity is greatest.

Organizations and companies within these pockets of electric capacity need are charged with improving the efficiency and load management of electric using equipment. To leverage DOE's funding to reduce the barriers to using high efficiency lighting systems, collaboration with these regional organizations to further develop technologies, conducting demonstration projects and communicating the viability and value of these technologies to building designers and owners makes logical sense.

- Market research conducted for the LRC for a daylighting project revealed the following:
 - Building designers and owners/developers have a positive attitude toward building design which makes widespread use of natural light.
 - The final decision about using daylighting and its associated lighting controls is a financial decision made by building owners/developers.
 - Building designers and owners/developers indicated the major benefits of daylighting are the occupants of the building feeling better/more comfortable, reduced energy consumption, increased employee productivity, improved building appearance/aesthetics and increased marketability of the building to tenants or buyers.
 - The greatest barrier to the expanded use of daylight is the capital costs involved; the second largest hurdle was problems with technologies including lighting controls.
 - Building designers and owners/developers said they most often get their information about daylighting from industry publications. Other sources included seminars, web sites, sales people/vendors, case studies and trade shows.

- Market research conducted by the LRC for a load-shedding ballast project revealed the following:
 - To attract business customers to load management programs, the cost to participate must be in line with the customer benefits.
 - Lighting is an excellent load to control because there is so much of it and there is little impact on building occupants or operations if controlled properly. Lighting also provides a predictable amount of load control.
 - An ideal lighting control scheme must allow the lights to be dimmed from a single location and must be easy to use.
 - Load-shedding ballasts must be cost effective and be easy to install.
 - Other important, required characteristics of load-shedding ballasts are: minimal impact on lamp life with no impact on the manufacturer's warranty; a "good housekeeping" seal of approval beyond the normal UL listing (such as the ENERGY STAR[®] mark); the signal to dim cannot create interference with other customer equipment; and technical support of the ballast and signaling equipment after installation.
 - Customers would allow utilities to control load-shedding ballasts directly if customers had override capabilities.

- Customers want demonstrated proof that the load-shedding technology works.
- Customers would first look to their utility for information regarding load-shedding ballasts and a related load management program and then to their trade associations.
- Electronic communications regarding information on load-shedding ballasts or load management programs is not desired by customers.

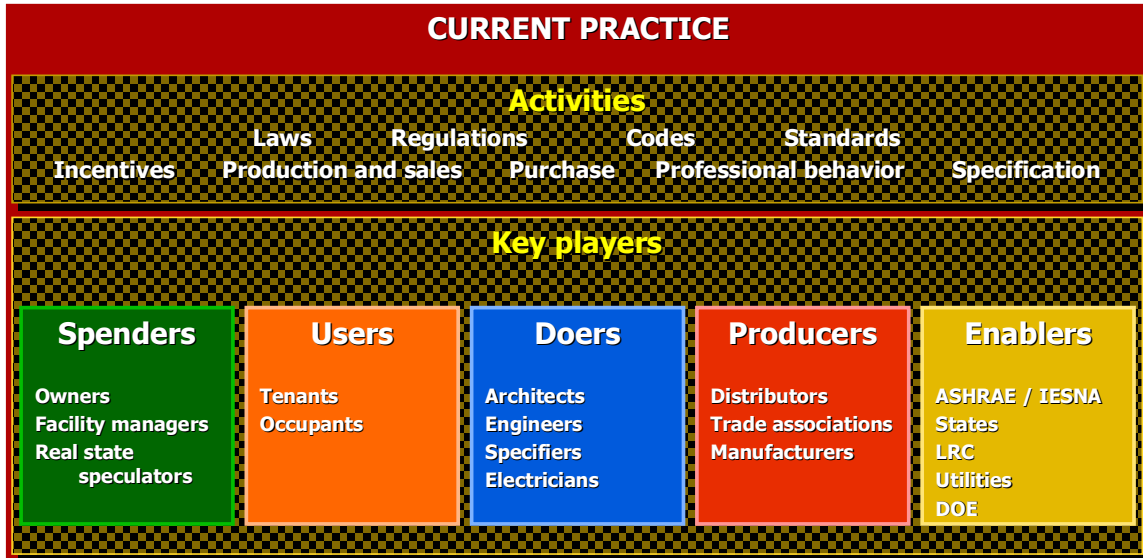
III. MEASURING SUCCESS

- Leverage DOE efforts and funding to reduce barriers to the use of high efficiency lighting systems by developing and securing proposals to further reduce barriers through demonstration and evaluation of lighting controls such as load-shedding ballasts and self-commissioning photosensors.
- Strategic regional organizations/corporations, where immediate needs such as electrical generation or transmission constraints can be alleviated by the use of lighting controls, participate with the LRC in technical transfer efforts thereby further leveraging DOE funds. These areas include southwest Connecticut, New York City, Long Island, extreme northern U.S. such as Idaho and Minnesota and the BPA in Northwest US.
- National organizations concerned with energy efficiency are convinced of the value lighting controls can play to the continued security and availability of electric energy and have agreed to include lighting controls in their energy efficiency agendas. These organizations include the National Electrical Manufacturers Association (NEMA), National Electrical Contractors Association (NECA), National Association of Energy Service Companies (NAESCO), Association of Energy Service Professionals (AESP), Building Operators and Managers Association (BOMA), Natural Resources Defense Council (NRDC) and American Council for an Energy Efficient Economy (ACEEE) These organizations represent the *spenders, users, doers, producers, and enablers* depicted in the following technology transfer model.
- DOE states at the end of the project that the LRC has met all of its obligations and the project has succeeded in promoting DOE's agenda for greater use of lighting controls.

IV. TECHNOLOGY TRANSFER MODEL

Successful technology transfer must recognize the technical foundation and market enabling mechanisms that are in play with each new technology and the organizations, companies and representatives (or players) that interact with these mechanisms. By knowing where a technology is in relationship to these mechanisms and who the drivers/players are to move the technology through the remaining steps of the mechanisms, a collaborative plan can be developed. The plan will reflect the strengths of each organization/player in their area of expertise. The plan coordinator must tailor communication efforts that are of interest to each organization so they willingly participate in the plan.

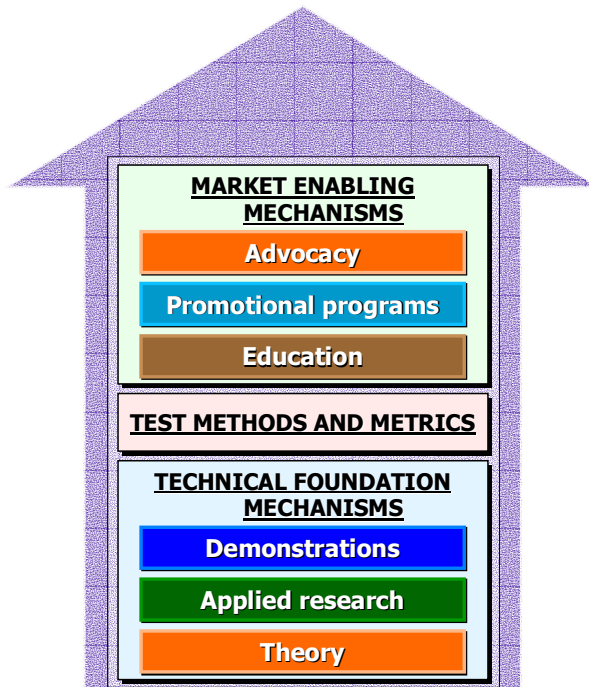
The figure below depicts the key players and activities they pursue under today's current practices of technology transfer. The ultimate goal of technology transfer is to have the technology so widely used that the impact of the technology is written into laws, regulations, codes and/or standards.



Key players include:

- **Spenders** – These are building owners, facility managers, real estate speculators and developers. They make the ultimate buying decision but are influenced by the other types of key players and what they read and see in different types of communication outlets.
- **Users** – These are the ultimate users of the technologies such as building tenants and occupants. They must be satisfied with the technology's performance and the ability to deliver its claims.
- **Doers** – These are the architects, consulting engineers, specifiers and installers of the technology. They have great influence over the *spenders*. When *doers* recommend or install a technology, they risk their reputation on whether product will perform as advertised.
- **Producers** – These are the people who make and distribute the technology and their respective associations/organizations. They must have a reliable and marketable technology that will earn profits for the company. Besides the key role of manufacturing the technology, they act as marketer.
- **Enablers** – These are the organizations that write laws, regulations, codes and/or standards such as state and federal governments, American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), National Electrical Manufacturers Association (NEMA) or Illuminating Engineering Society of North America (IESNA). Also included are organizations who influence law, regulation, code and/or are standard writers such as Natural Resources Defense Council (NRDC) or American Council for an Energy Efficiency Environment (ACEEE). *Enablers* are also represented by organizations such as the Lighting Research

Center who has relationships and partnerships with all of the key players within an industry and is able to bring these dissimilar types of players together in collaborative and mutually beneficial efforts to successfully perform technology transfer. Also included with this grouping are utilities and state/regional organizations such as Xcel Energy and the Northwest Energy Efficiency Alliance, which are charged with the responsibility for implementation of energy efficiency programs.



The transformation mechanisms shown are methodical, step-by-step processes for developing, demonstrating, evaluating, commercializing and, finally, customer acceptance of a technology. The successful achievement of each step's goals is a prerequisite to moving onto the next step. Failure to meet these goals or an attempt to skip a step reduces the chances of the technology being accepted by the *user*.

The mechanisms include:

- **Theory** – This mechanism identifies a possible technology to satisfy an unfulfilled customer or *user* need. The technology gets defined and researchers determine if the technology is achievable at some reasonable cost to the *user*. While research organizations like the LRC and other *producers* are the primary players for this mechanism, input from and funding to the other key players is mandatory.
- **Applied Research** – This mechanism must prove the technical and economic concepts of the technology through technical and market research. Prototypes are developed as part of meeting this step's goals. Again, close collaboration with all key players is necessary as the research or manufacturing organizations endeavor to meet the goals of this mechanism. As one of its goals, the applied research

mechanism identifies manufacturers willing to commercialize the technology and begin performing the necessary engineering for manufacturing.

- **Demonstrations** – Full scale demonstrations are necessary to “show the world” the technology works and delivers the promised benefits. The demonstrations must answer any questions or concerns raised by *users* or *spenders* during the market research phase. The proof must be of the technology and its economics as applied to an actual, rather than laboratory, situation. Successful demonstrations with multiple locations or situations increase the acceptance of the technology. Funding and defining the measured metrics for this phase must come from other key players.
- **Test Methods and Metrics** – The method and metrics on which the evaluation is conducted of a technology, especially during the demonstration step, must be acceptable and agreed to by the research community as well as all the key players. Test results must withstand the rigors of review. While this mechanism may seem intuitive, it may be the most important step of all transformation mechanisms. It sets the stage as to how believable the claims made by the technology will be to the *spenders, users, doers, producers* and *enablers* and, ultimately, how successful the technology will be in the marketplace. Also, it provides a uniform means to measure results utilizing the same technology in different labs and facilities.
- **Education** – The education mechanism is meant to be broad in scope to include the necessity to educate all the key players about the benefits, abilities and limitations of the technology and why it should be adopted in the marketplace, i.e. what it will do to help society. This is the first step in bringing the technology to the market. Yet, many times organizations responsible for technology development do not view the educational function as part of their responsibilities. Funding for education should be included as part of any technology development or else the technology may never advance to the market.
- **Promotional Programs** – If the rigors of the test methods and metrics are met and if a successful education program is funded and executed, then, and only then, will the *producers, enablers, utilities* and state/regional agencies charged with the conduct of energy efficiency programs promote the use of the technology to the *spenders, doers* and other *users*. Promotional programs can take many forms such as utility incentive programs or endorsements.
- **Advocacy** – This is the final step in the technology transfer model but does not occur until after the technology has reached some level of acceptance within the marketplace. It only occurs when there is public consensus of the use and benefits of the technology. Advocates then request that the benefits of the technology are included in regulations, codes and/or standards.

The technology transfer model works best when combining current practices with transformation mechanisms. One must identify the key players for each of the mechanisms for each technology to be transferred to the marketplace. As a result, this will allow for the development of a transfer plan with targeted audiences and messages.

The model works by identifying where the technology is along the mechanism steps and who the key players are to move it to the next step.

- If the technology is in relatively wide use, approach the *enablers* for the advocacy of the benefits of the technology to promote regulations, codes and standards.
- If the technology is ready for widespread use, use promotional programs to convince the *doers* and *spenders* of the benefits of the technology.
- If the technology has been developed and demonstrated to be of value but is not in use, convince utilities and others to promote the technology.
- If the technology has been developed but is not proven on a wide scale, seek funding for demonstration and evaluation projects and to educate *spenders*, *users*, *doers* and *enablers* of the unbiased results.
- If the technology is in the applied research stage, seek funding to prove/disprove the technology and its economics. Also seek someone from the *producer* segment to manufacture the product.
- In all cases, ensure communications across all key player types of the technologies possibilities, evaluations, etc.

V. WHERE LIGHTING CONTROLS TECHNOLOGIES STAND TODAY

- **Occupancy Sensors**
 - **Current status** - This technology is commercially available, viable and proven to save energy. Discussions concerning the amount of energy saved persist as well as how to select and install the correct occupancy sensor for a given application.
 - **Future technology transfer efforts** – This technology is ready for inclusion into codes and standards. Communication efforts must include providing decision makers (*doers* and *spenders*) with predictable energy savings as well as selection and installation practices.
- **Self-commissioning Photosensors**
 - **Current status** – This technology has been developed, is easily installed compared to other photosensors and as been shown to save energy under a small demonstration scenario. Economic viability under daylight conditions is marginal because of the cost of a fully dimming ballast.
 - **Future technology transfer efforts** – The technology needs to undergo the rigors of a full demonstration and evaluation to quantify energy savings, economically justify the technology and communicate the results. Funding for these activities should be sought from regional organizations (*users*) where electric capacity issues exist. Also, follow-up with manufacturers (*producers*) is necessary to fully commercialize this product.
- **Load-shedding Ballasts**
 - **Current status** – This technology is under development with a cost-effective ballast operation proven in the laboratory. The communication link from a central building controller to each ballast is also needed.
 - **Future technology transfer efforts** – Seek funding from regional organizations (*users*) to continue the development of this technology. A manufacturer (*producer*) willing to commercialize this product must be found if the product is technically and economically viable.

VI. DETAILED PLAN

The plan must meet the technology transfer objective and achieve the measures of success identified in this plan by meeting the needs of each key player for the technology in question (as partially identified in paragraph II, Factual Information). Using the model presented above for each of the three technologies (occupancy sensor, self-commissioning photosensor and load-shedding ballast) will facilitate identification of all key players needed to move the technology through the remaining steps of technology transfer. The plan presents a model for each technology and all of its key players and then identifies specific actions to be taken with specific key players, targeting completion during Year 3 of this project.

Since it is impossible to interact with each individual *spender, user, doer, producer* or *enabler*, the LRC must interact with organizations whose members represent individual companies, professionals, owners, etc.

General Actions

- The LRC will seek review of this plan and concurrence with proposed actions from state and regional energy efficiency organizations, lighting specifiers and other lighting decision makers.
- Develop and maintain a dedicated web site directed toward state and regional lighting decision makers to assist them in using lighting control technologies, keeping them informed as new/improved technologies become available on the market for the duration of this project.

Occupancy Sensor

	Status	Key Players				
		Spenders	Users	Doers	Producers	Enablers
Advocacy	Ongoing			NAESCO, AESP	NEMA	ACEEE, NRDC
Promotional Programs	Ongoing				manufacturers	Utilities, NYSERDA, CEC, NEEA
Education	Ongoing	BOMA	BOMA	ASHRAE, NECA, IESNA, AIA, NAESCO	NEMA	DOE, LRC, Utilities, NYSERDA, CEC, NEEA
Test Methods & Metrics	Complete					
Demonstrations	Complete					
Applied Research	Complete					
Theory	Complete					

Actions

- Prepare and publish an article for BOMA or a similar building owner/manager publication regarding the use and energy savings of occupancy sensors in office buildings.
- Prepare and publish the application and installation guide to occupancy sensors developed in Task 4 of this project and disseminate through NECA or similar organization of electrical contractors.
- Prepare and present a paper on the application and energy saving estimates of occupancy sensors developed as part of Task 4 of this project to ASHRAE, IESNA, AESP or similar professional organizations or to regional organizations charged with improving energy efficiency.
- Prepare and present the findings of the “Reducing Barriers to Use of High Efficiency Lighting Systems” project to NEMA, ASHRAE, IESNA or similar industry standard organization.
- Prepare and present the findings regarding the use of occupancy sensors to ACEEE, NRDC or similar energy efficiency advocacy groups so they will advocate the inclusion of occupancy sensors in future codes or standards.

Self-commissioning Photosensor

	Status	Key Players				
		Spenders	Users	Doers	Producers	Enablers
Advocacy	Not started				NEMA	ACEEE, NRDC
Promotional Programs	Not started				Manufacturers	Utilities, NYSERDA, CEC, NEEA
Education	Not started	BOMA	BOMA	ASHRAE, NECA, IESNA, AIA, NAESCO	NEMA	DOE, LRC, Utilities, NYSERDA, CEC, NEEA
Test Methods & Metrics	Ongoing				NEMA	LRC
Demonstrations	Ongoing	BOMA	BOMA		Manufacturers	LRC, DOE, Utilities, NYSERDA, CEC, NEEA
Applied Research	Complete					
Theory	Complete					

Actions

- Develop and submit a proposal for a full-scale demonstration project using the self-commissioning photo sensor to utilities, NYSERDA, CEC, NEEA or similar regional organizations charged with improving energy efficiency to measure energy savings and the ease of installation. This will leverage DOE expenditures in reducing barriers to the use of high efficiency lighting systems.
- Develop and submit a proposal for project funding on lamp/ballast compatibility testing under dimming conditions.
- Prepare and present the uses and benefits of a self-commissioning photosensor to utilities or regional organizations charged with improving energy efficiency.
- Develop and present the benefits and uses of the self-commissioning photosensor to lighting professionals and codes/standards writers.

Load-shedding Ballast

	Status	Key Players				
		Spenders	Users	Doers	Producers	Enablers
Advocacy	Not started				NEMA	ACEEE, NRDC
Promotional Programs	Not started				Manufacturers	Utilities, NYSERDA, CEC, NEEA
Education	Not started	BOMA	BOMA	ASHRAE, NECA, IESNA, AIA, NAESCO	NEMA	DOE, LRC, Utilities, NYSERDA, CEC, NEEA
Test Methods & Metrics	Ongoing				NEMA	LRC
Demonstrations	Ongoing	BOMA	BOMA		Manufacturer	LRC, DOE, Utilities, NYSERDA, CEC, NEEA
Applied Research	Ongoing					LRC, DOE, Utilities, CEC, NYSERDA
Theory	Complete					

Actions

- Leverage DOE funding for the “Reducing Barriers” project by developing and submitting a proposal to develop the communication links for load-shedding ballasts to utilities or regional organizations charged with improving energy efficiency in states or regions where electric capacity is constrained.
- Develop and present to NRDC, ACEEE, or similar advocacy organization information on the value of using lighting as a load management tool and the lighting control schemes utilizing load-shedding ballasts that will encourage businesses to shed lighting loads so they may advocate their use in codes and standards.
- Prepare and publish an article for a BOMA or similar building owner/manager publication or NAESCO or similar *doer* publication on the values of using lighting systems for electric load shedding.

VII. RECOMMENDATIONS FOR CONTINUATION OF INFORMATION DISSEMINATION

The plan above clearly indicates a need for continuation of information flow in the form of published articles, presentations, education and a dedicated web site to move occupancy sensors, self-commissioning photosensors, load-shedding ballasts and other lighting controls through the technology transfer model. As technologies are developed, demonstrated and evaluated, information on their values and uses must be presented to the spenders, users, doers, producers and enablers so they are eager to commercialize the technology and feel comfortable with the potential accomplishments of the technology. Communication with these groups creates a “pull” for the technology from the *spenders* and *users* and a “push” from *doers*, *producers* and *enablers*.

As a minimum, the dedicated web site should be maintained and updated quarterly with existing and emerging lighting control technology information. The information should include factual data on the technical and economic merits of the technologies. The web site can be turned over to DOE at the end of this project for continued maintenance or DOE can issue a request for proposal for the maintenance of the site.

It is further recommended that any future DOE grants for the development of lighting control technologies include funding for technology transfer activities such as the publication of articles in professional journals, presentations of the technology to regional and national organizations and seminars or other education opportunities to teach *spenders*, *users* and *doers* to properly specify, install and use the technology. Development of a technology, by itself, will not ensure successful introduction into the marketplace. Dissemination of accurate, defensible information is necessary to garner acceptance.