eeBuildings: EPA's International Energy-Efficient Buildings Program

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ABSTRACT

This paper profiles efforts by the U.S. Environmental Protection Agency (EPA) to assist building owners and managers in developing countries to improve the energy efficiency of commercial buildings. These efforts draw primarily on domestic experience EPA has gained in working with energy efficiency through commercial building voluntary programs. The work has been carried out by the International Capacity Building Branch (ICBB) of the Office of Atmospheric Programs (OAP) at EPA, whose mission is to help protect the global atmosphere by working to provide key developing countries with basic tools to reduce emissions of greenhouse gases.

As part of its international efforts, the ICBB created the International Energy-Efficient Buildings Program, known as eeBuildings. The eeBuildings program draws its approach primarily from EPA's domestic experience with the ENERGY STAR® Buildings and Green Lights voluntary programs. Specifically, eeBuildings matches the assets of these programs to the particular needs and barriers of its fieldwork market. This approach is based on several years of experience in developing country markets, which indicated that it could achieve effective results. This paper offers numerous lessons learned and observations based on this experience.

The eeBuildings program is built on fieldwork supported by a newly developed website that provides access to the national building benchmarking tool and other useful information and networking opportunities. Currently, the eeBuildings program is active in Brazil, China and the Philippines. Based on the progress of the program thus far, the authors believe that it is a valuable effort to be continued and developed further.

Introduction

The International Capacity Building Branch (ICBB) of the Office of Atmospheric Programs (OAP) at the U.S. Environmental Protection Agency (EPA) is implementing the International Energy-Efficient Buildings Program, known as eeBuildings (hereinafter referred to as "the program"). The mission of the ICBB is to help protect the global atmosphere by working to provide key developing countries with basic tools to reduce greenhouse gas (GHG) emissions. The program helps advance this mission by providing assistance to commercial building owners and managers based on EPA's U.S. experience in promoting building energy-efficiency improvements.

Program Logic

The 1990s saw many advances in energy efficiency for commercial office buildings in the United States. These were seen not only in equipment and building materials, but also in innovative thinking, new approaches for government action, and market transformation efforts. The same changes have occurred in other countries to varying degrees, depending on macroeconomic conditions, the state of the electrical generation and distribution systems, the energy intensity of homes and buildings, the availability of energy-efficient technologies, and other factors. As electricity supplies are deregulated and privatized, and as electricity use and peak demand continue to grow, the managers of the program believe that U.S. lessons and experience will continue to be valuable in developing countries.

In any given market there is a mix of participants, some promoting energy efficiency, others clinging to the status quo by selling or using inefficient lighting or HVAC equipment. The program contributes to the energy-efficiency dialogue, promoting sustainable change through education and engage of government officials, energy-service providers, and building owners and managers. The program leverages the convening power and credibility of EPA and its experience with building energy-efficiency programs in the United States. to support and promote local efforts to improve energy efficiency.

Program Goals

The program's goals are to create lasting environmental benefits while transforming markets for building energy-efficiency equipment and services. Specifically, the program seeks to:

1. Achieve direct environmental impacts through reductions in GHG emissions by promoting energy-efficiency investments in commercial buildings.
2. Realize indirect GHG reductions by transforming markets to more widely employ energy-efficiency measures, and strengthening the related infrastructure, including government agencies, non-governmental energy-efficiency programs, and suppliers of energy-efficiency goods and services are.
3. Gain additional benefits for partner countries through reductions in energy intensity and consumption of electricity and corresponding reductions in demand placed on sometimes-strained national generation, transmission, and distribution systems.

Program Assets

The program is based on the following EPA experience:

1. *The Green Lights and ENERGY STAR® Buildings Programs*. In these efforts, EPA developed numerous strategies, tools, and methods to address potential energy savings from lighting upgrades and other building energy-efficiency measures. Much of the Green Lights and ENERGY STAR Buildings materials have been useful in the program's activities.
2. *The ENERGY STAR Benchmarking Tool*. EPA created this web-resident tool to compare energy efficiency in individual buildings to the overall U.S. building stock, adjusting for differences in building type, size, plug load, hours of operation, occupant density, weather, and climate. The tool generates a building energy-performance score, using a scale of 0 – 100, based on data entered into the website by building management personnel. A score of 75 would indicate that a building is more

efficient than 75% of U.S. buildings; a score of 50 is average. The tool has achieved considerable success in the United States, and over 4,200 buildings have been scored through 2001. The tool can be used both in the United States and in most key cities outside of the United States.

3. *Long-term international experience sharing voluntary approaches*. Much of the experience guiding the program was gained through earlier OAP participation in cooperative international efforts to limit releases of ozone-depleting substances from 1990 - 1997, as well as other activities to promote energy efficiency in developing countries.

Program Accomplishments

Philippines

A project in the Philippines served as the program's pilot effort. The capital, Manila, has a large commercial office sector (about 6 million square feet of Class A space) and many opportunities for investment in energy efficiency. Several key factors were relevant in Manila during the time the program was active there, from 1999 – 2001:

1. *Volatile and rising electricity rates*. Electric rates include surcharges for the U.S. dollar/Philippine Peso exchange rate and the price of oil. In mid-2000, the cost of electricity for a typical office building could be as high as U.S. $0.15/kWh.
2. *Financial instability*. The 1997 Asian financial crisis and political turmoil in the Philippines made borrowing difficult and expensive. Companies were hesitant to take on extra debt, even for projects with very attractive rates of return.
3. *Use of efficient equipment*. Most commercial office lighting systems still used 40W T12s and standard magnetic ballasts. Limited lighting upgrades had occurred, but replaced only the lamps, missing most of the savings. The only widely known use of T8 lamps and high-frequency electronic ballasts was in the Asian Development Bank headquarters.
4. *Use of compact fluorescent lamps (CFLs)*. CFLs used to replace incandescent lamps was common and generally accepted. An International Finance Corporation (IFC) project, the Efficient Lighting Initiative (ELI), was promoting CFL replacement, but did not promote upgrades of linear fluorescent lamp systems.
5. *Multiple decision-makers*. Many buildings in Manila were divided into office condominiums where lighting and office environment issues were left to the condominium owners or tenants. Each building thus included multiple decision-makers when any capital expenditures were considered.
6. *Factors to encourage upgrades*. Occupancy rates and lease rates were generally falling, creating interest in upgrades as a way to retain and attract tenants and reduce operating costs (in turn improving net operating income). Softness in the market also meant that building owners, who in other circumstances would have focused time and capital on developing new buildings, had resources available for building upgrades.

The program's market transformation efforts in the Philippines were based on an understanding of the market that developed over several years of ICBB activities. Each stage of the Philippines effort was driven by an analysis of key stakeholder barriers and market conditions. Activities began with efforts to introduce and test the ENERGY STAR Benchmarking Tool. Working with local partners revealed a high level of interest in understanding and addressing energy efficiency in buildings. The program expanded its activities to assist building owners and managers in analyzing and undertaking potential energy efficiency upgrades. Through this process, the program identified key market barriers and worked with local partners to develop tools and approaches for overcoming those barriers. This process included the following set of key activities and accomplishments.

Recruited twenty local partners. Members of the program team met with executives of major building owners and managers in Manila to recruit organizations to partner with the program. Partnerships were sought in investigating opportunities for profitable investments in energy efficiency and to undertake upgrades. The partnership was based on an informal agreement that, at a minimum, the partners would provide feedback on tools and other assistance that was offered. The space owned or managed by partner companies exceeds 16 million square feet of office space in all classes, accounting for more than 30 percent of the total commercial office building space in Manila.

Tested international use of the ENERGY STAR benchmarking tool and interpreted results. The partners were offered the opportunity to submit building data to have buildings benchmarked using the ENERGY STAR Benchmarking Tool. Seventeen partners in Manila submitted data to have their building benchmarked, 12 of which received scores, as reflected in Table 1.[1]

Table 1. Manila Pilot Benchmarking Scores

Score	kWh/square meter	BTU/square foot
8	510	162
21	468	148
56	264	84
81	173	55
82	168	53
83	188	60
86	175	55
87	173	55
92	171	54
92	149	47
96	146	46
96	101	32

[1] At that time, the tool was not available on the Internet for non-U.S. users. Program staff generated scores using data supplied by building owners. Some buildings for which data were submitted could not be scored because they had unusual space-type mixes.

Partners received a score report and the table of scores above. This permitted comparison to U.S. buildings and other local buildings, without revealing the identities of the other scored buildings.

Testing the benchmarking tool included visiting ten of the benchmarked buildings to measure the indoor environment as compared to U.S. standards. The temperature, relative humidity, carbon dioxide levels, lighting levels, and space per worker were noted for multiple spaces in each building. Program staff had been told that buildings in Manila had lower energy intensities than U.S. buildings, but were not necessarily more energy efficient. A comparison of benchmarking scores, temperatures, humidity levels inside of buildings verified that the best scoring buildings in Manila were not cooling to the same extent as similar U.S. buildings. The average temperature of air coming out of registers in these buildings was 75 degrees Fahrenheit with humidity levels over 60 percent. Very high airflow mitigated the higher temperatures, creating a comfortable yet drafty environment that appeared to suit local preferences. The three lowest scores (least efficient buildings) reflected buildings that either had high cooling requirements due to sensitive computer equipment (two cases) or European and North American tenants (the third case).

Prepared lighting demonstration upgrade analyses. Five of the partners agreed to consider lighting upgrade demonstration projects. The results of the analyses that were prepared in support of these projects are summarized in Table 2 below.

Table 2. Upgrade Analyses Results --T12 with Magnetic Ballast to T8 with Rapid-Start Electronic Ballast

	Number of Fixtures	Lamps/ Fixture	Weekly Hours of Operation	10-Year IRR	Simple payback
Project 1	255	2	60	32%	3.7 years
Project 2	100	1	168	37%	2.8 years
Project 3	32	1	60	22%	4.9 years
Project 4	150	2	55	39%	3.3 years
Project 5	225	2	168	94%	1.3 years

Partners identified a space for a lighting upgrade demonstration project. Program staff then prepared a detailed analysis based on the existing equipment, upgrade options, cost of electricity, and use of the space. This analysis included cash-flow tables on particular upgrade options over a 20-year period, detailed recommendations about lighting upgrade options, and recommended lighting levels for space-types as indicated in ASHRAE/IES 90.1. Program staff prepared presentations to accompany the demonstration project analyses and delivered them to partner contacts and others within partner organizations.

Created lighting upgrade tools. To assist partners with lighting upgrade projects and ultimately raise awareness about the whole market, the program produced several tools. These tools included an energy-efficient lighting procurement guide (see Appendix) and a lighting upgrade life-cycle cost analysis tool (a spreadsheet application). The program also provided promotional materials to help individuals sell the concept of lighting upgrades inside their organizations.

The procurement guide was distributed to lighting manufacturers and suppliers as well as partners. In several instances, lighting manufacturers incorporated the procurement guide information into their sales promotions. The Energy Managers Association of the Philippines (ENMAP) published the procurement guide and a sample output of the lighting upgrade life-cycle cost analysis tool in the June 2001 issue of their official publication, *The Energy Manager*.

Obtained involvement of local lighting manufacturers. The local representatives of major lighting manufacturers carried energy-efficient lighting products in their catalogs, but did not sell many locally because of what they perceived as a lack of local demand. At the same time, program partners indicated that they had asked about efficient products, but were discouraged because of minimum purchase requirements, long lead times for orders, and no assurance that replacement components would be available. Program staff worked to overcome this breakdown in communication.

The manufacturers were interested in the results of the demonstration project analyses. While they had reservations about whether companies in Manila would complete the projects, they did not want to be an impediment. As a result, manufacturers identified contacts that were knowledgeable about energy-efficient options and who could work with partners interested in energy-efficient systems.

Helped PLDT become a local "champion" of energy-efficient lighting. With over 5,000 buildings in metro Manila, the Philippines Long Distance Telephone Company (PLDT) is concerned about energy use. PLDT was also one of the first and most enthusiastic program partners interested in improving energy efficiency. As a result, the program worked to help develop them as a champion partner. They had a lighting upgrade project already in place, but it concentrated on the shortest payback, rather than the upgrades with the highest financial returns. They were essentially reducing the total number of lamps in fixtures and replacing 40W T12 lamps with 36W T8 lamps, but leaving the old magnetic ballasts in place. The result was less energy use and lower light levels, but little improvement in energy efficiency.

PLDT had previously been disappointed with the reluctance of lighting manufacturers to promote lighting upgrades. Using tools and analyses supplied by the program, PLDT was able to obtain bids on a demonstration project from several manufacturers, with the understanding that more work would follow if the project met the projected savings goals. Because managers at PLDT and other companies were skeptical about whether the savings would be real, quantifying savings was an important step.

In its demonstration project, PLDT upgraded 325 fixtures, reducing the energy use of each fixture by 28 percent. The project will save approximately 48,000 kWh per year and pay for itself in just over two years. The 10-year internal rate of return was approximately 48 percent. The initial demonstration was followed by a 5,000-fixture upgrade project.

Organized conference on energy-efficient lighting. In partnership with the Philippine Department of Energy (PDOE), the program hosted a conference on upgrading commercial office lighting systems. The Conference was subscribed to capacity, with 57 local participants, including 37 who attended a break-out session on the use of the life-cycle cost analysis tool. Program partners, representatives from lighting manufacturers and contractors, and officials from local utilities attended the event.

In addition to a review of lighting upgrade opportunities, the conference included presentations by the PDOE testing lab and remarks by the Undersecretary of Energy. PLDT received an award for their leadership in energy-efficient lighting in Manila. At the conference, PLDT discussed their efforts and announced more extensive upgrade plans.

The following successes resulted from the conference:

1. Lighting contractors performed a demonstration project in the offices of the Secretary of Energy.
2. PLDT began negotiating a performance contracting arrangement with a local electric utility.
3. The local program representative made a presentation on lighting energy-efficiency at a conference for energy efficiency in the Philippines semi-conductor industry.

Table 3 below summarizes the schedule of trips to Manila, primary purposes, and outcomes.

Table 3. Fieldwork in Manila

Dates	Primary Purpose	Primary Outcomes
May 1999	Opportunity analysis and discussions with the Philippines Department of Energy (PDOE) and Department of Natural Resources	Decided to move forward with the buildings work
October 1999	Recruit Partners	Recruited 7 Partners
June 2000	Gather benchmarking and lighting data	Recruited 13 additional partners; collected benchmarking data for 17 buildings and 5 lighting demonstration projects
December 2000	Present benchmarking score and lighting demonstration analyses	Presented scores and assessed indoor conditions for 10 buildings; presented 5 lighting demonstration analyses to partners and summary results to 3 lighting manufacturers and PDOE
June 2001	Host lighting conference	Hosted conference with 57 participants, including award ceremony for PLDT; conducted lighting upgrade analysis training for 37 participants

Other Research - Brazil

Because ICBB was already working with PROCEL, a Brazilian energy-efficiency organization, on another energy-efficiency project, the program decided in 2001 to conduct fieldwork in São Paulo, Brazil, following its experience in the Philippines.

At this time, São Paulo was experiencing very low vacancy rates in commercial office space. Since tenants typically paid for utilities, there was little incentive to invest in upgrades in tenant-occupied buildings. Moreover, many buildings had numerous—in some cases hundreds—of owners, many of whom prioritized immediate cash income. This situation had developed because individuals had invested in building condominium shares to protect themselves against inflation. Over time, these investments would further divide as a result of inheritance, divorce, or other circumstances. Therefore, lighting upgrade investments, needed approval by a large number of people with differing interests and abilities to invest.

The activities untaken in Brazil drew upon the base of knowledge obtained in the Philippines. During fieldwork in February and September 2001, the program collected data for four benchmarking scores and met with the following key stakeholders:

1. Staff from PROCEL and INEE, national energy efficiency agencies;
2. The environmental and energy departments for the State of São Paulo;
3. The American Chamber of Commerce Energy Committee;
4. Six leasing agents, real estate brokers, and real estate services companies in Rio de Janeiro and São Paulo;
5. A major real estate management company and a group of managers from ten of their client properties;
6. The local retail electric utility in São Paulo;
7. The Brazilian offices of two U.S. ENERGY STAR Partners;
8. Two major lighting manufacturers; and
9. Staff from ABILUX, the association of Brazilian lighting professionals.

Lessons Learned

Fieldwork to date has shown that economically attractive technological opportunities exist that can create a favorable market for equipment and services that improve commercial building energy efficiency. The program's work with partners in developing country markets has demonstrated, through technical and financial analysis that substantial upgrade opportunities exist. These opportunities can offer economically attractive reductions in energy consumption and carbon emissions associated with energy production. The program's commercial building sector contacts are clearly interested in learning about EPA energy-efficiency activities and in receiving assistance from EPA. While many companies are constrained by short financial time horizons, they want to learn more about the possibilities to improve energy efficiency. However, while viable opportunities and interest are often in place in developing country markets, barriers remain that prevent stakeholders from acting on them. EPA experience suggests that directed analysis and technical assistance can help overcome those barriers.

There is also broad interest in energy-efficiency benchmarking in commercial buildings, especially among managers of Class A space. Because the program's research has shown that multinational tenants are a key driver of new building technologies, owners and managers of Class A space are very receptive to tools and strategies that will allow them to market their space to these tenants more effectively. Managers of Class A space are looking to compare their buildings to international standards rather than local standards, although local comparisons are still of interest to them.

Other lessons learned include the following:

1. *A market transformation approach to promoting energy efficiency improvements is critical*. Evidence from fieldwork suggests that information and technology exchange often does not occur in developing countries when such activities are part of a disconnected, stand-alone approach. The EPA program succeeded in moving the

market toward greater energy efficiency because it identified and demonstrated specific economically attractive technological opportunities, identified barriers to those opportunities, designed measures to address those barriers, and adjusted those measures over time.

2. *Building owners and managers in developing countries need technical assistance to achieve greater energy efficiency*. While they are very receptive to making improvements in energy efficiency, they often are not equipped with the knowledge or tools necessary to analyze their buildings' efficiency, identify opportunities for efficiency improvements when they exist, develop strategies for potential efficiency improvements, or work with technology suppliers to specify and procure energy-efficient equipment and services.

3. *Market intervention can have a positive effect.* This effect is seen particularly when it occurs within the context of a focused market transformation approach. In the Philippines, while economically attractive technological opportunities existed to incorporate more-efficient building technologies, these opportunities were not acted upon since key stakeholders were not aware of how to pursue mutually beneficial strategies. EPA involvement resulted in buildings owners interacting directly with key technology suppliers and service companies to begin identifying opportunities and acting on them. In this role, EPA was able to fill critical gaps in the communication process, which helped technology suppliers identify the market for more efficient technologies, and helped building owners understand the equipment and services they need from suppliers.

4. *When pursuing a long-term strategy for transforming the market for technologies and services, becoming a regular participant in the market transformation process is critical*. For outside groups pursuing specific interventions, this suggests regular in-country fieldwork to: 1) develop adequate understanding of the local market; 2) establish credibility by demonstrating sustained commitment; and 3) motivate partners to action. While outside groups may be well-known for providing high quality assistance, effective knowledge and relationships need to be established in order to ensure effective results. Frequent contact also provides milestones for in-country partners, which helps to drive activities and results.

5. *New technologies are viewed with greater suspicion in developing country markets.* Causes of this are: 1) manufacturers continuing to manufacture obsolete products and sell them in developing country markets; 2) early models suffering from quality problems; and 3) complex technologies, such as building management systems, being misapplied. Once a technology develops a bad reputation, the negative effects persist for a long time.

6. *In the Philippines and Brazil, building ownership structures make it challenging to implement energy-efficiency improvements*. Condominium-style ownership of multiple commercial units within a single building is commonplace. Under these circumstances, multiple owners and decision-makers are required in order to act on energy-efficiency opportunities. Incentives are often reduced, because non-resident owners may be able to pass on energy costs to tenants, and have less interest in reducing energy costs than in owner-occupied buildings.

7. *There are often different incentives in specific markets.* This requires that adequate research be conducted prior to designing intervention measures. In Brazil, for

example, social responsibility relating to their energy crisis was a key driver in corporate willingness to pursue building energy-efficiency upgrades.

8. *Local champions can have a significant impact on the success of international programs*. Local champions can provide critical local momentum. However, such champions are difficult to identify. The most effective strategy for identifying and leveraging local champions is to be engaged in a particular market over time, and build effective relationships.
9. *Multi-national corporations (MNCs) as tenants are an important driver in certain developing-country real estate markets*. MNCs bring knowledge and experience from other markets, prompting local brokers and leasing agents to respond to demand that they do not see from their local clients. Enlisting MNCs with developing-country operations provides a yet unexplored option for program expansion.
10. *Demonstration projects are essential, but must be carefully designed*. Some partners may be reluctant to make upgrades until they see actual results (e.g., Philippines partners interested in seeing PLDT upgrade results). Some upgrades may also be seen by local partners as unrepresentative of their actual environment (e.g., the Asian Development Bank (ADB) upgrades in Manila were well known, but the ADB was perceived as having abundant capital as well as the ability to import equipment duty-free). Successful upgrade efforts may not be seen as relevant to other building owners and managers, who face different circumstances.

Observations

1. *Barriers are often present*. High energy costs may not provide the degree of incentive expected for pursuing profitable energy-efficiency upgrades, especially when other barriers exist that prevent action from being taken.
2. *International leasing and management firms play key roles in developing country markets*. These groups often: 1) represent building space for clients, and are eager to use energy efficiency as a sales point to help them deliver greater value; 2) manage space, and recommend value-added technology choices for owners and tenants; 3) represent tenants, and can help tenants identify advantageous space characteristics, such as energy efficiency; and 4) represent MNCs, which often drive local building technology adoption.
3. *In the Philippines, working with owners of existing buildings can affect the design process since the developers are often long-term owners*. This is different from the U.S. experience of buildings that are built, transferred, and traded frequently. Consequently, owners in Manila were unmoved by the notion that energy-efficiency upgrades increased the sale value of a building.
4. *The willingness to accept new building technology in the Philippines had been damaged by widespread problems with building automation systems (BAS) installed in the late 1980s*. These systems were inappropriately commissioned, poorly maintained, or not properly upgraded to accommodate changes in building operation. In some cases the vendors went out of business. Problems with these systems undermined other building system upgrades. For example, some variable frequency drives (VFDs) were observed on manual override because the BAS was down or could not control the VFDs satisfactorily.

5. *Comparison to U.S. buildings is appealing*. Although program staff were concerned that the benchmarking tool compared local buildings to U.S. buildings, partners saw this as an advantage instead of a drawback. Partners were more interested in how their building compared to the U.S. building stock than to local buildings, which many did not consider to be a useful reference. Additionally, when non-U.S. comparison was discussed, they were more interested in Pan-ASEAN benchmark statistics than local Manila statistics.
6. *Investment times can be short*. In circumstances where interest rates are high, capital is scarce, and the economy is volatile, investment time horizons tend to be relatively short. Consequently, even very profitable upgrade opportunities may be foregone.
7. *Performance Contracting (and ESCO industry development) are dependent upon a good understanding of the technology or confidence in the ESCO*. Prior to the Manila lighting upgrade conference, program staff found no evidence of any locally initiated performance contracting, despite the fact that several companies called themselves ESCOs. They were doing fee-for-services projects while waiting for the industry to develop. In Brazil, ESCOs did not have a good reputation with the building managers contacted by the program. They are viewed by some as an expensive form of financing. One company had incorporated many cost-effective efficiency upgrades in larger tenant space improvement packages. These projects typically focused on improving the comfort, safety and security of the space, and the energy-efficiency features reduced the life-cycle cost of the upgrades.
8. *Case studies are valuable*. Local case studies are an effective tactic for communicating information to local partners, since they can provide directly relevant information at a level of detail that is useful for other players in the same market.

Future Activities

Based on the experience and lessons learned from activities in the Philippines and Brazil, the program is continuing with a focus on both in-country fieldwork and an international website.

Fieldwork

Fieldwork in key EPA target countries will continue to be the foundation of the program. This will allow EPA to bring assets directly to its partners and other in-country stakeholders. It is anticipated that EPA will expand the program into new developing-country markets, and that additional program approaches and tools will be explored during this expansion process. As EPA's domestic building energy-efficiency programs continue to grow and evolve, there may be additional opportunities to incorporate new experience into the programs activities.

Web Site Development

The program is launching a Web site in May 2002, which will be found at www.epa.gov/eeBuildings. Five primary goals have been identified for the Web site:

1. *Benchmarking.* It will provide an international face and context to the ENERGY STAR Benchmarking Tool. EPA, in conjunction with the U.S. Department of State, recently adapted the ENERGY STAR Benchmarking Tool to score buildings in 170 cities outside the United States. The eeBuildings Web site will provide outreach and assistance in the use of the tool to building managers in key Asian and Latin American cities.
2. *Deliver technical assistance.* The Web site will organize and present technical assistance tools and materials developed by the program. It will include assistance to partners in countries where there is no active fieldwork.
3. *Fieldwork Support.* The Web site will directly support fieldwork activities, providing a library of materials, a reference for people seeking more information about the program, and a center for program communication.
4. *Recognition.* The website will serve as a platform for recognition of outstanding buildings, projects, and organizations.
5. *Online community building.* The website will create the possibility of replicating many of the benefits of fieldwork through development of an active online community.

China Potential

Substantial potential for energy savings and pollution prevention exist in China. The program will focus its efforts on Shanghai, a city with over 22 million square feet of class A office space and over 70 million square feet of total office space (Colliers). Building construction and energy consumption growth rates in Shanghai and the rest of China exceed those in the United States and other developed countries. Additionally, China's main fuel for its electricity generation is coal, which emits about 2.4 pounds of CO_2 per kWh compared with the average of 1.6 pounds in the United States.

The China commercial buildings sector consumes about 25 percent of China's electricity with about 33 percent going to lighting and nearly 50 percent going to air conditioning (Luo). With a 20 percent savings in total building energy use, Class A buildings in Shanghai alone could save 792 million kWh per year, or almost a billion pounds of CO_2 emissions.

Fieldwork in China is beginning, as shown in Table 4. OAP and ICBB have cooperated with China on energy efficiency since 1989. In late 2001, ICBB was approached by the Chinese Ministry of Construction and the Center for Energy Conservation Products (CECP) to discuss collaborative efforts to improve energy efficiency in buildings.

Table 4. Fieldwork in Shanghai

Dates	Primary Purpose	Primary Outcomes
November 2001	Participate in Energy Foundation Conference in Shanghai.	Initiated discussions with CECP and The Center for Energy Efficiency in Buildings. at the Ministry of Construction. Recruited one building owner as a partner.
May 2002	Perform market research; identify potential partners.	Pending as of the writing of this paper.
July 2002	Continue discussions with CECP and the Ministry of Construction; recruit Partners.	Pending as of the writing of this paper.

Conclusion

Program efforts to date have been well received by developing country businesses and government entities. The authors believe that by building upon this experience, eeBuildings can achieve real and lasting improvements in the energy efficiency of commercial buildings. Feedback and ideas for collaboration are welcome.

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Energy-Efficient Lighting Procurement Guide (front)

Commercial Lighting Procurement Guide

Philippines

32-Watt Linear T8 Lamps and High-Frequency Electronic Ballasts

Using this guide

This guide is designed to assist with procurement of 4-foot linear fluorescent lamps and high-frequency electronic ballasts primarily for retrofit applications. Retrofit refers to changing lamps and ballasts without replacing the entire fixture. The suggested technologies, high-frequency 32-Watt T8 lamps and high-frequency electronic ballasts, offer greater energy efficiency and higher quality illumination without sacrificing light levels. In order to achieve energy savings and reliable operation, the lamps must be used with electronic ballasts specified to operate the high-frequency 32-Watt T8 lamp.

High Frequency Electronic Ballast (Gear) Specifications (to be used with 4-foot high-frequency 32-Watt T8 lamp)

Performance Characteristic	Specification (requirement)	Notes
Ballast Type	High-Frequency Electronic	
Mains (Building System) Frequency	50/60 Hz	Make sure the correct frequency is specified.
Mains (Building System) Voltage	220v/277v	Choose ballasts that match the voltage of your mains.
Total Harmonic Distortion (THD)	< 33%	Acceptable THD levels depend on the amount of sensitive electronics on your electrical system.
Voltage Tolerance	± 20% of mains voltage	This is especially important if voltage fluctuations are frequent.
Lamp Operating Frequency	> 20 kHz	
Power Factor (PF)	≥ .90	If fixtures include PF correction devices for magnetic ballasts, they should be removed when high PF electronic ballasts are installed.
Ballast Factor	.85 – 1.00	Choose a lower ballast factor if the area is overlit and save more energy. Choose a higher ballast factor if more light is needed.
Lamps/ballast	1 to 4	It may be possible in some cases to replace multiple magnetic ballasts with a single electronic ballast. Ballasts should always be specified for the number of lamps they will drive. Consult your lighting supplier or electrical contractor.
Circuit type	Instant-start or rapid-start	Instant-start is generally more efficient, but rapid-start is better if the lights are frequently switched on and off, as is the case when using occupancy sensors.
Current Crest Factor	< 1.7	
Manufacturer Warranty	At least three years	

eeBuildings

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Energy-Efficient Lighting Procurement Guide (back)

32-Watt Linear T8 Fluorescent Lamp Specifications

Performance Characteristic	Specification (requirement)	Notes
Fluorescent Lamp Type	High-frequency linear T8	
Lamp Length	4 Feet (1200 mm)	Other lengths of HF T8 lamps are expected to be available in the Philippines in the near future. When planning retrofits, make sure that the correct length is specified.
Lamp Wattage	32 Watts	Some T8s are 36W. The 32W lamps are the correct choice for use with high-frequency ballasts.
Color Rendering Index (CRI)	At least 75	This ensures high quality lighting as well as high efficiency. When possible, choose lamps with CRI greater than 80.
Color Temperature	Depends on user preference 4000K lamps are preferred for maximum efficacy (lumens/Watt).	32-Watt T8 high-frequency lamps are available in Kelvin color temperatures such as 3000, 3500, 4000, 5000, and 6500. Higher color temperatures produce cooler light. They usually are referred to by names such as "Cool White." Match color temperature to occupant preferences.
Rated Lamp Life	Minimum 20,000 hours rating	The rated life is the expected number of burn hours until 50% of the lamps have burnt out.

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Procurement Checklist

- ❑ Lamp/Ballast Compatibility: Electronic ballasts must be specified to operate 32W high-frequency T8 lamps. Using a ballast not specified to operate a 32W high-frequency T8 lamp will reduce lamp life by as much as 50%.
- ❑ Minimum Order Quantity: Some manufacturers require a minimum order quantity for 32W high-frequency T8 lamps and electronic ballasts. Make sure you have enough storage space to handle minimum orders. Check with local suppliers and manufacturers and discuss the options.
- ❑ Delivery Times: Lamps and ballasts should be ordered at least two months before installation to allow time for delivery. Manufacturer delivery times could be as long as eight weeks.
- ❑ Verification of the Technologies: Upon purchase and delivery of the lamps and ballasts, purchasers (building owners and tenants) should inspect the shipment to verify the proper lamps and ballasts were delivered.
- ❑ Replacement Lamp: Purchasers should check with local suppliers for availability of replacement lamps and ballasts to be purchased in small quantities. Suppliers should stock adequate supplies (lamps and ballasts) to meet replacement orders by building owners and tenants. Make sure that lamps of the correct color temperature will be available. Occupants will see differences in color temperature, which may detract from their satisfaction.
- ❑ Warranty: The terms of the warranty should be discussed and understood by the purchaser. The discussion should include details about how quality problems will be addressed.

The United States Environmental Protection Agency (EPA) has provided this document through eeBuildings. The goal of eeBuildings is to help owners and managers of office buildings profitably improve their energy efficiency and thereby reduce atmospheric emissions associated with the generation of electricity. ICF Consulting assists EPA in implementing eeBuildings.

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