BUILDING ENERGY EFFICIENCY

Why Green Buildings Are Key to Asia's Future

An Asia Business Council Book

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Asia Business Council

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PREFACE

I am pleased to present the Asia Business Council's study on building energy efficiency. This book, the first that the Council has published, takes an incisive look at a serious challenge facing Asia.

The study concentrates on market-based solutions to an important aspect of the energy and environmental challenges the region faces. Buildings account for nearly one-third of energy use and a similar proportion of total global greenhouse gas emissions.

More than half of the world's new construction is taking place in China and India alone. Studies estimate that these two countries could cut current building energy consumption by 25 percent simply by using energy more efficiently. Similar savings are available for many other Asian economies.

Building Energy Efficiency represents an excellent example of the sort of work that you will see from the Council: in-depth research that has bottom-line implications for Council members but also has wider implications for the economies in which we live and work.

Dr. Ruth Shapiro, the founder and former executive director of the Asia Business Council, identified the importance of building energy efficiency and guided the research and much of the writing process. Dr. Wen Hong and Madelaine Steller Chiang did the vast bulk of the research, wading through copious amount of literature, interviewing more than 70 people throughout Asia and marshalling research done by New Delhi's The Energy Research Institute. Mark Clifford, the Council's new executive director, pushed the team to expand the project into a book. Finally, editor Margarethe P. Laurenzi nurtured what began as a brief research report through repeated drafts.

The Council is dedicated to producing research on key issues facing Asian companies and the societies in which we operate. We will continue to build on work we have done in areas such as corporate governance, education, energy, the environment, finance, health and technology.

The rapid economic growth of the past several decades has put Asia at the center of global events. Although the value of intra-regional trade has surpassed that of exports from the region, ideas have been slower to cross Asia's borders.

The Council hopes that by putting good ideas into the realm of public debate Asia will be able to build a more prosperous tomorrow. It is time for all of us in the region to take a more active role in shaping responses to the increasingly complex opportunities and challenges that our societies face. We hope that this book will go some way toward that goal.

N.R. Narayana Murthy
Chairman
Asia Business Council

INTRODUCTION

Buildings are some of the biggest energy consumers in the world, accounting for one-quarter to one-third of all energy use and a similar amount of greenhouse gas emissions. While cars have had to meet increasingly strict fuel efficiency standards, buildings for the most part have gotten off easy. Surprisingly little attention has been paid to ensuring energy efficiency in buildings, despite the tremendous impact buildings have on costs and the environment.

That oversight is starting to be addressed. A combination of higher energy prices, skyrocketing demand for electricity and deepening environmental concerns has pushed Asia to a tipping point with regard to energy efficiency in buildings. Simply put, business as usual threatens Asia's continued prosperity.

As one example of the changes that are occurring, the Clinton Foundation recently announced an unprecedented initiative to funnel up to US$5 billion in loans from some of the world's largest banks (Citigroup, JP Morgan, Deutsche Bank, UBS and ABN Amro) to fund building retrofit projects that increase energy efficiency. Five of the 16 cities chosen for this pilot project—Bangkok, Karachi, Mumbai, Seoul and Tokyo—are in Asia.

The economics are powerful, promising quick paybacks on investments for building developers and their tenants. The economic case is equally strong for governments, which are furiously building power plants in an attempt to keep up with surging demand from new buildings and their often inefficient air-conditioning, windows and lighting.

China alone is building one or two new coal-fired plants *every week* to try to keep up with electricity needs. To make the economic case for greater energy efficiency even more compelling, most Asian economies are net fuel importers. High energy prices at a time of rapid growth have pushed up import costs and raised concerns about the security of energy supplies.

The environmental case is every bit as strong as the economic one. The authoritative Intergovernmental Panel on Climate Change in its most recent report noted: "It is often more cost-effective to invest in end-use energy-efficiency improvement than in increasing energy supply to satisfy demand for energy services. Efficiency improvement has a positive affect on energy security, local and regional air pollution abatement and employment."[1]

Global concern over climate change and the role of greenhouse gas emissions gathered critical momentum in the past year. Against a backdrop of increasing international concern over climate change, an unprecedented statement by China's President Hu Jintao in June 2007 on the need to take the threat of climate change seriously testifies to the growing importance of this issue in China.

Efficiency, after all, is the economic equivalent of a free lunch. Greater efficiency means consumers can enjoy the same level of comfort but use less energy. And when it comes to efficiency, improvements in buildings offer the most cost-effective way to reduce energy use and greenhouse gas emissions. The McKinsey Global Institute, which has studied the issue on a worldwide basis, estimates that four of the five most cost-effective measures taken to reduce greenhouse-gas emissions involve building efficiency. (The measures are building insulation, lighting systems, air conditioning and water heating. Improved efficiency for commercial vehicles is the only non-building issue to make it on to the top five list.)

Incredibly, these measures result in net savings for building owners and their tenants, because their cost is so cheap compared to the savings. Indeed, some utilities actually pay consumers to use energy more efficiently because it is cheaper for the utility than building a new power plant.

With high-energy prices likely for the foreseeable future, the world may have little choice but to make a concerted effort to use energy in buildings more efficiently. Globally, McKinsey says that overall energy demand will accelerate from 1.6 percent a year in the past decade to 2.2 percent annually over the next 15 years unless wide-ranging efficiency measures are taken. (Commercial and residential demand is expected to grow at similar rates as these overall figures.)

Asia is the biggest contributor, making up nearly half of the additional worldwide energy demand that McKinsey expects over these 15 years. *China alone is expected to account for four times as much of the absolute growth as the United States.* It's a surprising number, but considering that China is in the midst of the largest move from farm to city that the world has ever seen, it's less surprising. Hundreds of millions of Chinese peasants are becoming urban, where they'll expect the same air-conditioned comfort, the same well-lit houses, the same always-on hot water as other city-dwellers around the country and world. Much the same thing is happening in India and throughout the rest of developing Asia, albeit on a smaller scale.

Building green buildings and making old ones greener alone is not going to solve the world's environmental problems. Nor is it going to lead to energy independence or plummeting utility bills. But it is one of the most important single areas on which we will see increased focus as the world struggles to adapt to climate change. The impulse for building energy efficiency is not only about turning down the aircon or turning off the lights—it is about doing more with less. Just as factories have become vastly more productive over the past decades, consumers can expect much more out of energy use ten years from now. These productivity improvements will enable hundreds of millions of people to live and work in more comfortable offices and apartments.

Where does Asia fit into this picture of better energy standards? How much has the creed of better building practices been adopted in Asia? What barriers exist that slow the adoption of energy-efficient building practices? And if this is such a great idea on both economic and environmental grounds, why hasn't it already taken off?

These are some of the questions that Asia Business Council researchers have examined over the past year in an in-depth study of the problems and opportunities of increased building energy efficiency. This ground-breaking study, which included interviews with more than 70 experts throughout the region and overseas, comes at a time when there is a growing consensus among business leaders and policy makers that increased energy efficiency must occur. But there is much less consensus about how to make that general consensus a reality.

Key Findings

- Energy efficiency is one of the quickest, cheapest, cleanest ways to address energy and environmental challenges. In China, gaining a megawatt of electricity by building more generating capacity costs at least four times as much as saving a megawatt through greater efficiency—and that ignores the environmental costs of generating power using fossil fuels. Yet the great potential for efficiency improvement is largely untapped in Asia.
- Buildings account for around 30 percent of the world's total energy consumption and a similar percentage of the world's greenhouse gas emissions, the main cause of climate change. Buildings last decades. The way buildings are designed and constructed today will not only have an impact on their operating costs, but will affect the world's energy consumption patterns and environmental conditions for many years to come.
- More than half of the world's new construction is taking place in Asia. China is constructing almost half of the world's new build-

ings, while in India, the built-up area more than doubled in the past 5 years. Studies estimate that China and India could cut current building energy consumption by 25 percent, with cost-effective improvements in energy efficiency.

- Contrary to popular perceptions, industry interviews and research confirm that many energy savings initiatives can be achieved with little or no cost through careful building design mandated by project developers and good management practices of building operators and occupants.
- Many technological and other solutions exist to improve building energy efficiency, as seen in the numerous green building projects being developed around the world. The greatest challenges in improving energy efficiency are human—educating, disseminating and making decisions to utilize existing and new solutions.
- In the absence of well-designed policy measures that stimulate both the supply and demand sides of the equation, improvements in building energy efficiency will continue at a slower pace. Governments have a role in mandating regulations that will create a level playing field and help industry build capacity.
- It makes financial sense for businesses to monitor, respond, and lead the trend toward greater building energy efficiency. For building developers, smart design techniques and high-efficiency building components are the key to maximizing energy efficiency. The starting point for operators and occupants is to make energy management a business priority. More generally, looking at total costs over the life-cycle of a structure should underpin decision-making for everyone involved in a building.
- Industry associations in Asia, to date, have not played a significant role in this change, leaving initiatives largely to government. This trend differs from the U.S. and Europe where industry initiatives are one of the driving forces behind a market-led transformation toward greater efficiency and sustainability in the built environment.

- As the global movement towards more sustainable growth gains momentum that would have surprised many people even five years ago, business and governments will have to re-think their assumptions and chart new ground.

PART I – BUILDING ENERGY EFFICIENCY: A NEW BLUEPRINT

High Energy Costs and Environmental Concerns Drive Efficiency

The world is in the midst of a global building boom of unprecedented scale, with significant consequences for global energy use. Today, commercial and residential buildings account for about one-third of the world's final energy consumption.[2] Industry and transport also each use about one-third of energy. However, because most buildings today do not have smokestacks, most people give little thought to their contribution to increased levels of energy use and thus air pollution.

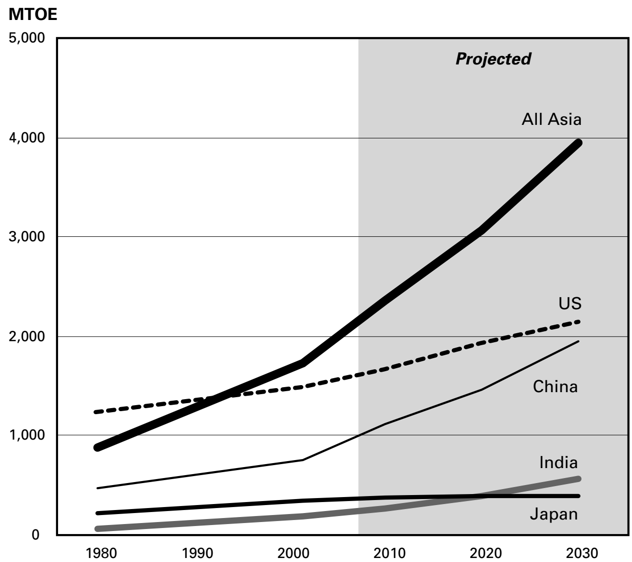
Energy consumption is the major source of greenhouse gas emissions, the main cause of climate change, and the building sector is a major energy consumer. In fact, research in the U.S. shows that when 'embodied energy' is considered—the energy required to produce the materials such as carpet, tile, glass, and concrete used in construction—carbon dioxide (CO_2) emissions from the building sector exceed those of the industry and transport sectors.[3] In this sense, buildings are intensifying global climate change that may affect weather patterns, sea level, and the land masses that support life.

Unlike cars or air conditioners, buildings last decades; the way buildings are designed and constructed today will translate directly to better or worse energy efficiency in the building sector, with an impact both on the operating costs of the built environment as well as the world's energy consumption patterns and environmental conditions for many years to come.

A Growing Demand for Energy

Just as much of Asia's economic growth exceeds the global average, the region's growing energy needs have become a key component of surging worldwide energy demand. From 1971 to 2004, the world's total final energy consumption increased 87 percent, with an annual average growth rate of 1.9 percent. Around 43 percent of the total increment was attributable to Asia, where final energy consumption increased 275 percent, with an average annual rate of 4.1 percent, more than twice as fast as the global average. The world's final energy consumption is expected to increase 1.5 times from 2004 to 2030. Fully half of that in-

Figure 1: Total Final Energy Consumption (1980-2030)



Note: "Asia Total" includes the 11 Asian economies covered in this study: China, Hong Kong, India, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan and Thailand.

MTOE is 'Million Tons of Oil Equivalent'.

Source: Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf; the data for India is from the Institute of Energy Economics, Japan (IEEJ), 2006, "Asia/World Energy Outlook 2006", see: http://eneken.ieej.or.jp/en/data/pdf/362.pdf crease will come from Asia, with its share of the world's energy demand expected to increase from 27.6 percent to 35.2 percent during the same period (see Figures 1 and 3).

This virtual explosion of energy consumption is raising concerns about Asia's energy security and environmental sustainability. Asia's dependence on imported oil is expected to grow from 55 percent in 2004 to 89 percent in 2030. Most importantly, Asia will increasingly depend on imports from the Middle East and Africa for many of its increased energy demands.[4] Geopolitical uncertainty in these regions and the prospect of global oil price rises means that it makes good economic sense to curb energy use as much as possible without hurting economic growth.

China, for example, already has the world's biggest balance-of-payments deficit for oil. Yet its demand for oil is expected to nearly double from 2003 to 2020.[5] Energy prices are expected to have an outsized influence on China's trade balance and GDP growth.

The environmental impact is every bit as worrying. From 2004 to 2030 the world's CO_2 emissions are projected to increase around 50 percent, absent any global agreement to limit emissions. More than 57 percent of that projected increase will come from Asia, with China alone accounting for 30 percent, putting great pressure on environmental sustainability in Asia and the world.

Greater Emphasis on Energy Efficiency in Asia

Although some Asian economies began to take energy efficiency into account as early as the late 1970s after that decade's two oil shocks, economic development remained the priority of most Asian governments for the past few decades. The foremost objective of Asian economies' energy policy was to provide enough energy to fuel their growth. Under such a strategy, development in the region has been accompanied by a high growth rate of energy consumption and concomitant heavy pollution.

Since the 1990s, however, Asian economies have begun to make strategic changes in their energy policies. An extensive review of energy policies in the 11 Asian economies where the Asia Business Council has members (China, Hong Kong, India, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan, and Thailand) shows greater balance now between security and sustainability concerns, and increased focus on wise consumption of energy along with an emphasis on adequate supply. The drivers for such change include:

- Concerns over resource depletion and energy security. Most Asian economies are energy importers. As energy consumption has risen rapidly, Asian governments are increasingly considering the possibility that energy shortages and increasing dependency on imported oil could become a bottleneck hindering economic growth and threatening national security. Sky-rocketing energy prices and occasional sporadic disruptions to energy supplies by some producing countries in the past few years have strengthened the arguments of those who want to examine the way energy is used in their economies. Improving the productivity of energy consumption is quickly becoming an unavoidable necessity.
- Concerns over pollution and environmental damage. Heavy pollution and environmental damage have spurred concerns among Asians about the air they breathe. Consumption of energy, the biggest contributor to air pollution, has become an urgent matter that Asian governments can no longer ignore.
- Recognition of the major contribution energy efficiency could make in addressing energy security and environmental challenges. Energy efficiency is one of the quickest, cheapest, cleanest ways to address energy and environmental challenges, and is one well-proven strategy practiced worldwide. In China, gaining a megawatt of electricity by building more generating capacity costs at least four times as much as saving a megawatt through greater efficiency, according to estimates by the Natural Resources Defense

Council and Information Center of the Chinese Ministry of Land and Resources.[6] Yet the great potential for efficiency improvement is largely untapped in Asia.

- International pressure and the desire for international recognition. Asia's energy consumption and the consequent environmental impact are of great concern to the international community. International pressure has been growing for Asia, particularly China and India, to take prompt measures to deal with the environmental and energy effects of rapid economic growth. A variety of NGOs, international organizations, foreign governments and consultants have poured money and people into Asian countries to help governments, businesses and ordinary people improve energy-efficiency policies and practices.

Driven by these internal and external forces, there have been some changes in the objectives and strategies of Asian economies' energy policies since the 1990s.

Before the 1990s, the objective of Asian economies' energy polices were mainly to enhance energy security by acquiring adequate energy supplies to meet the needs for economic and social development. In the 1990s, Asian economies began to seek a balanced policy that addressed both energy security and environmental sustainability; environmental issues have since moved to the forefront of energy policies. In most Asian economies' written energy policies, achieving environmental sustainability is included as one key objective, along with ensuring energy supplies for social and economic development (see Box 1 and Part III for the evolution of national energy policies in the 11 Asian economies).

In light of recent hikes in energy prices, tight energy supply-demand conditions and the geopolitical situation in Middle East, energy security has returned to the top of most economies' energy agendas. However, almost all Asian economies are beginning to address the problem of global warming in their energy policies, since the energy sector is the main source of greenhouse gas emissions in Asia. One of the major strategic responses of Asian economies has been to place greater emphasis on energy conservation and efficiency and renewable energy sources, in order to secure energy as well as to reduce emissions.

This study does not look in detail at the relationship between energy prices and conservation. However, higher prices do spur efficiency efforts. Japan's high electricity prices have helped make it one of the leaders in Asia in building energy efficiency. The subsidized energy prices prevalent in many countries, whether of electricity or gasoline, make efficiency gains more difficult to achieve.

Before the 1990s, focusing on the supply side was the common approach of most Asian energy policies. In the last decade, however, Asian economies have begun to stress the demand side of the energy sector, trying to achieve greater balance between a stable energy supply and rational utilization of energy. Asian economies have recognized that increasing energy efficiency before increasing supply is more economically efficient; energy efficiency is increasingly seen as an alternative source of energy supply and an important tool in achieving energy security and reducing reliance on imports (see Box 1 and Part III for the evolution of national energy policies in the 11 Asian economies covered by this study.)

These two trends indicate a greater emphasis, at least in their written policies, on energy efficiency as a national goal in Asian economies, as a way of addressing the challenges of energy security and environmental sustainability.

A Booming Built Environment in Asia

With Asia's surging economies, the region is adding to its built environment at an unprecedented rate. Every year, more than half of the world's new buildings are constructed in Asia. China is the world's largest construction market. It has 40 billion square meters in existing

Box 1: Energy Policies in Asian Economies

China: The national energy policy emphasizes energy conservation along with other principles such as optimization of the energy consumption mix, promotion of environmental protection, and protection of energy security.

Hong Kong: Energy policy aims to (1) Ensure that the energy needs of the community are met safely, efficiently and at reasonable prices; (2) Minimize the environmental impact of energy production and use; and (3) Promote the efficient use and conservation of energy.

India: Energy policy focuses on 'energy for all' and intends to build an environment-friendly sustainable energy supply industry.

Indonesia: The five objectives of its national energy policy include: (1) Energy diversification; (2) Intensification in energy exploration; (3) Energy conservation; (4) Energy price based on market mechanism; and (5) Promotion of environmental protection.

Japan: National energy policy aims to: (1) Establish Japan's energy security; (2) Solve the energy problem and the environment problem together; and (3) Contribute actively to a worldwide solution to the energy problem.

South Korea: Energy policy focuses on the 3Es: Energy Security, Energy Efficiency, and Environmental Protection.

Malaysia: Three principal objectives of the national energy policy are (1) To ensure the provision of adequate, secure and cost-effective energy supplies; (2) To promote the efficient utilization of energy; and (3) To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

Philippines: The goals include: (1) Supply security and reliability; (2) Energy affordability and accessibility; (3) Environmental quality; and (4) Consumer protection

Singapore: The national energy policy stresses six key strategies: (1) Focus on conservation and efficiency to reduce the increasing rate of energy consumption, enhance sustainable development, and mitigate greenhouse gas emissions; (2) Enhance the role as a regional petroleum refining and trading center; (3) Promote the country as a regional hub for an integrated gas pipeline network; (4) Restructure and privatize the power sector; (5) Energy reservation; and (6) Participation in overseas exploration, and production.

Taiwan: The aims of the energy policy are to establish a liberalized, orderly, efficient, and clean energy supply and demand system based on the environment, local characteristics, future prospects, public acceptability, and practicability.

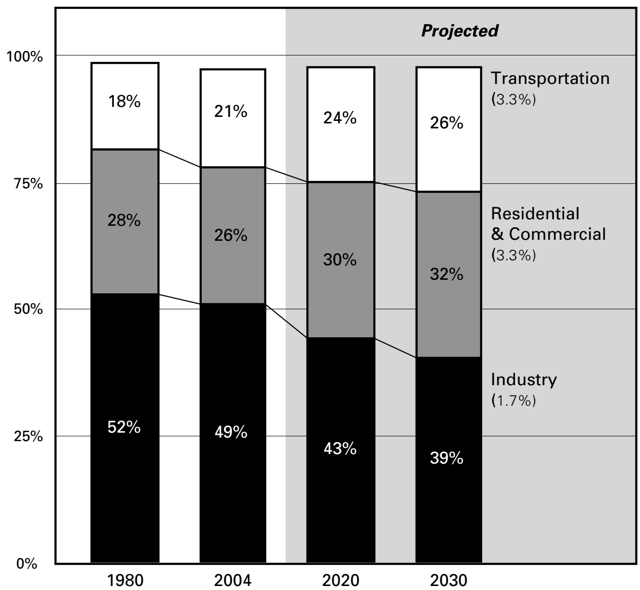
Thailand: The national energy policy emphasizes: (1) National energy security and reducing dependency on energy sources from foreign countries; and (2) Promoting efficient and economical use of energy and the use of renewable energy sources to reduce total energy demand and protect the environment.

buildings and adds an additional two billion square meters of floor area each year, almost half the global total.[7] In India, the built area more than doubled between 2000 and 2005.[8]

Much of the new construction in Asia is large commercial office buildings and mixed-use developments that embrace such modern design features as glass facades and centralized air conditioning. While a handful of developers across Asia are making increased use of energy-efficient components, most projects under construction do not take into consideration the many design and technology options available to mitigate the high energy costs associated with these popular designs.

The building sector currently accounts for about one-quarter of Asia's final energy consumption.[9] With overall social and economic

Figure 2: Asia's Final Energy Consumption by Sector



Note: Figures in parentheses refer to projected average annual growth rate from 2004-2030. Percentages do not add to 100 percent due to exclusion of other sector demand.

Source: Data from the Institute of Energy Economics, Japan (IEEJ), 2006, "Asia/World Energy Outlook 2006", see: http://eneken.ieej.or.jp/en/data/pdf/362.pdf trends that signal continued strong economic growth, ongoing population explosion, increasing urbanization, living standard gains, and changing lifestyles, Asia will require a dynamic construction market and more energy to meet its needs for space and water, heating/cooling, lighting, and operating appliances and equipment. From 1971 to 2004, total energy consumption in the building sector in Asia increased more than 260 percent, and is forecast to grow at an average annual rate of 3.3 percent until 2030, nearly twice the rate of industry—reaching 30 percent of Asia's total final energy demand by 2020[10] (see Figure 2). The growth rate in East Asia and India is expected to be particularly high. The average annual growth rate of total building energy consumption in the 11 economies is forecast to be as high as 5.7 percent for the 2002-2030 period, compared to 3.9 percent in the U.S.[11] (see Figure 3).

With such a rapid growth rate, the share of buildings in Asia in the world's total energy consumption increased from 3.7 percent in 1971 to 7.3 percent in 2004, and is expected to increase to 11.2 percent in 2030 (see Figures 4 and 5). According to the World Bank, in China alone, each year lost in developing more efficient buildings locks in some 700 to 800 million square meters of urban residential and commercial building floor area of inefficient energy use for future decades[12]—equal to more than 100,000 soccer fields. If aggressive efforts are not made now to improve the energy efficiency of Asia's construction boom, Asia will be trapped in an energy-intensive built environment for years to come.

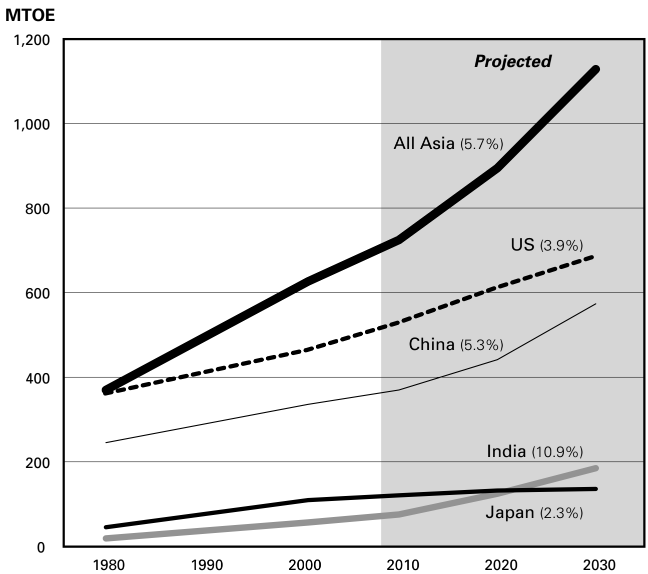
A recent study by the World Bank estimates that China and India could cut current energy consumption in the building sector by 25 percent, with cost-effective retrofitting of high-efficiency lighting, air conditioners, boilers and waste heat recovery systems—technologies that are widely available today.[13] This estimate tracks with reports from China's Ministry of Construction stating that 95 percent of existing building are "highly energy-consuming" and that energy consumption per unit of area in China is currently two to three times that of developed countries in achieving the same comfort level.[14] In India the government estimates an energy-saving potential of over 30 percent for commercial buildings.[15]

Global Momentum for More Energy-Efficient Buildings

Recognizing the worldwide impact that buildings and their construction have on the environment, governments have been exploring ways to achieve greater sustainability of the built environment.

In 2003, the European Union issued the Directive on Energy Per-

Figure 3: Final Energy Consumption by Buildings (1980-2030)



Note: "Asia Total" includes the 11 Asian economies covered in this study: China, Hong Kong, India, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan and Thailand; Figures in parentheses refer to projected average annual growth rate from 2004-2030.

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Source: Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf; the data for India are from the Institute of Energy Economics, Japan (IEEJ), 2006, "Asia/World Energy Outlook 2006", see: http://eneken.ieej.or.jp/en/data/pdf/362.pdf formance of Buildings, integrating a variety of policy tools including energy performance certificates for all building construction, sale and rental transactions to promote the energy performance of buildings in member states. EU member states have until 2009 to fully implement the directive.[16] The European Commission launched the GreenBuilding Program (GBP) in 2004 for the purpose of improving the energy efficiency and expanding the integration of renewable energy in non-residential buildings in Europe on a voluntary basis. In a pilot phase in the years 2005-2006, the so-called GreenBuilding infrastructure was set up in ten European countries supported by the European Commission's Intelligent Energy Europe Program.[17] And the International Energy Agency (IEA), together with the G8 countries, initiated the IEA Work Program on Buildings in 2006 at the invitation of the G8 and the IEA Governing Board, to review energy-efficiency building standards and standards in OECD and developing countries, develop energy indicators to standardize the assessment of energy efficiency, and identify and recommend policy best practices.[18]

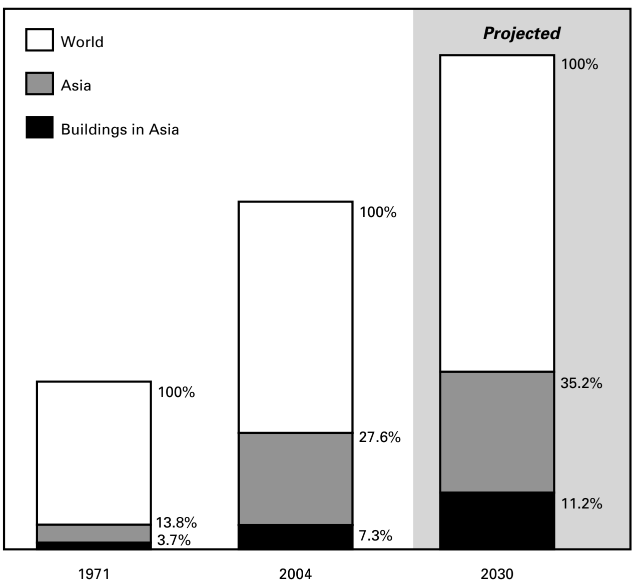
This drive for greater energy efficiency and improved building sustainability is increasingly a business concern. Industry-led efforts have sought to transform market practices across the building industry.

The U.S. Green Building Council (GBC), founded in 1993, seeks to fulfill the U.S. building and construction industry's vision for its transformation to high-performance green building. The organization developed the LEED (Leadership in Environmental and Energy Design) Green Building Rating System, which is currently used voluntarily in the U.S. and in 24 countries.[19] The success of the U.S. Green Building Council led in 1999 to the formation of the World Green Building Council, a non-profit organization that focuses on sustainability in the building industry, and the Green Building Councils in its nine member countries. Another 30 countries are actively considering establishing Green Building Councils, and many of them have established their own green building rating systems.[20] As a result of the emergence and widespread adoption of green building rating systems, "green building" has become a well-accepted term to describe buildings that meet an established set of environmental performance criteria typically including site consideration, energy efficiency, water and materials usage and indoor environmental quality (see Box 2).

Increased attention to the environmental impact of buildings has emerged as a source of wider policy concerns. Two recent international initiatives are particularly noteworthy.

In March 2006, the World Business Council for Sustainable Development (WBCSD) announced an alliance of leading global companies to examine how buildings can be designed and constructed so that they use no energy from external power grids, are carbon neutral and can be built and operated at fair market values by 2050. Member companies include CEMEX, DuPont, EDF, Gaz de France, ITT, Kansai Electric

Figure 4: Total Final Energy Consumption

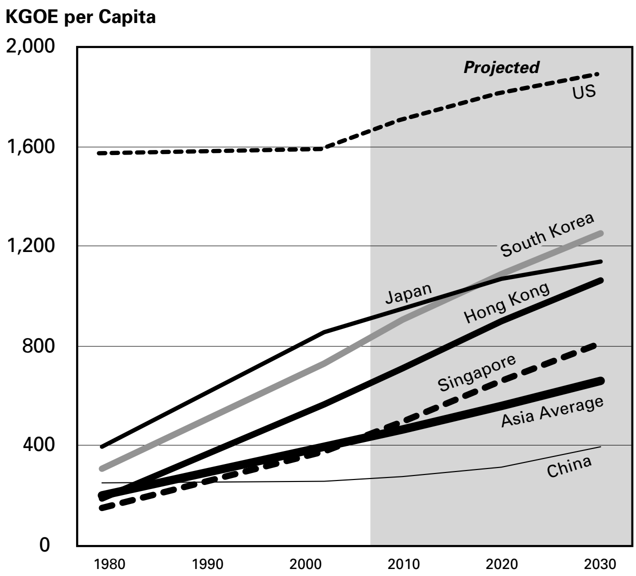


Source: Based on data from The Institute of Energy Economics, Japan (IEEJ), 2006, "Asia/ World Energy Outlook 2006", see: http://eneken.ieej.or.jp/en/data/pdf/362.pdf

Power Company, Lafarge, Philips, Sonae Sierra, TEPCO, and United Technologies Corporation. The project scope includes both residential and commercial buildings and focuses on China, India, Brazil, the U.S. and the EU.[21]

Another significant initiative is the US$5 billion global Energy Efficiency Building Retrofit Program of the Clinton Foundation's Clinton Climate Initiative (CCI). Announced at the C-40 Large Cities Climate Summit in May 2007, Bill Clinton said that up to US$5 billion in private funds will be lent by five major banks—Citibank, UBS, Deutsche Bank, ABN Amro and JP Morgan—for retrofitting buildings. The retrofits will include energy-saving improvements and installation of

Figure 5: Per Capita Energy Consumption in Buildings



Note: Data for India are not available. "Asia" includes China, Hong Kong, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan and Thailand.

KGOE is 'Kilograms of Oil Equivalent'.

Source: Data from Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf energy-efficient products, changes that typically lead to energy savings of between 20 and 50 percent. Five of the 16 pilot cities for the project are in Asia—Bangkok, Karachi, Mumbai, Seoul and Tokyo.[22]

There are also a growing number of energy-efficient buildings around the world, including many in Asia (see Part II for Asian cases). Some governments and business organizations are pursuing a target of zero-energy buildings, structures that put back into the system at least as much energy as they take out, or zero-carbon buildings that produce no net carbon emissions from all energy uses in the buildings.

The UK government is studying a proposal for moving toward zero-carbon homes, which would require all new homes in England

Box 2: Green Building and Green Building Rating Systems

The OECD defines green buildings as those that have minimum impacts on the built and natural environment in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting. This is a very general definition, so a number of groups have tried to provide a more measurable set of criteria with which green buildings can be measured.

Over the past 15 years, green building rating programs, which assess buildings against a set of established environmental performance criteria that typically include site consideration, energy, water and materials usage, and internal air quality, have emerged around the world for the purpose of recognizing buildings that achieve superior environmental performance. Initiated either publicly or privately, these voluntary rating programs provide guidance for design, construction and operational practices that significantly reduce the environmental impact of the development.

The most well-known such system is the Leadership in Environmental and Energy Design (LEED) green building rating system of the U.S. Green Building Council. LEED promotes expertise in green building through a comprehensive system offering project certification, professional accreditation, training and practical resources. To obtain a LEED certification, a building project must satisfy a certain number of prerequisites and performance benchmarks ("credits") related to site sustainability, energy efficiency, material and resource conservation, and indoor environmental quality. Projects are awarded Certified, Bronze, Silver, Gold, or Platinum certification depending on the number of credits they achieve.

LEED has become an internationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED-certified buildings are found in 24 countries, and owners of LEED-registered and certified projects represent a diverse cross-section of the building industry. As of July 1, 2007, to be carbon-neutral by 2016.[23] The government also said in March 2007 that it would consider plans for zero-carbon "eco-towns" that could lead the way in cutting carbon emissions and building affordable homes, based on zero-carbon technologies (see Box 3).[24]

Providing energy services has become a growing business. Energy service companies (ESCOs) helping companies improve their building energy efficiency and maintenance costs originated in North America and Canada and have spread to many parts of the world (see Box 4).

In general, these initiatives launched by government, industrial associations, and companies are laying the groundwork for market transformation towards greater sustainability in the built environment.

Box 2 Continued

884 projects from 24 countries were certified under LEED Commercial Rating Systems, and more than 7000 projects have registered and are waiting for LEED approval; 222 projects were certified under the LEED Homes Rating System (for the U.S. and Canada only) with more than 6,000 projects registered and waiting for approval.*

With the growing body of evidence supporting the financial and environmental benefits of green building, builders, governments and companies around the world are increasingly adopting green building practices and seeking certification as a way to differentiate their products and demonstrate environmental credentials. As one example of a multinational corporation actively pursuing green building initiatives, Citigroup has launched a real-estate portfolio review of the 13,000 properties it owns and leases in more than 100 countries to investigate what levels of renovation or operational changes are needed to earn LEED or equivalent ratings for everything from Citigroup's office buildings to its data centers. The company has also established a green building rating as a target for all its new office and operations facilities around the world. In the U.S. market, the McGraw-Hill 2006 Smart Market Report predicts that green non-residential construction will comprise as much as 10 percent of all non-residential construction starts by 2010. The U.S. Green Building Council reports that the products and services market for green building is expected to exceed $12 billion in 2007.

In Asia, the green building movement is newer but shows evidence of a similar trend. Among the 11 Asian economies reviewed in this study, Japan, Singapore, South Korea, Taiwan, Hong Kong, India and China all have green building rating systems; most of these have been devised within the last 5 years (see Part II & III for more information).

**Information from the U.S. Green Building Council, see: http://www.usgbc.org/*

More Energy-Efficient Building in Asia

The trend toward energy-efficient buildings has gained momentum in Asia over the past decade, with substantial government initiatives promoting building energy efficiency launched since 2000. The three largest energy consumers in Asia—China, India and Japan—have all taken aggressive policy measures.

China, for example, has issued three new building standards since 2000. It has increased the energy-saving target for new buildings from 30 to 50 percent, measured as per square meter energy consumption to achieve the same comfort level (compared with the 1980s level). Major cities are subject to an even higher target of 65 percent. In addition, targets have been established for energy-saving retrofitting of existing buildings, with large cities expected to improve 25 percent of the building stock.

Since the Kyoto Protocol was negotiated in 1997, Japan has been strengthening its building energy policies to support its national goal of CO_2 emissions reduction. Voluntary energy standards for both residential and non-residential buildings were revised in 1999, and the government is planning to make them mandatory in 2007. Japan also enacted the Housing Quality Assurance Law in 2000 as well as a voluntary energy-efficiency labeling system. In 2004, the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) was developed; it was updated in 2006 (see Part III for more of Asian economies' policy initiatives).

In 2001, India developed its first national building energy standard, which targeted a 25 to 40 percent energy consumption reduction in new buildings.

Similar trends are taking place in other Asian economies. For example, building energy standards were (or are being) reviewed and upgraded in most of the other surveyed economies: Singapore 1999, Malaysia 2001, Hong Kong 2005, Thailand 2001-2005, and the Philippines 2005. South Korea formally adopted its first building energy standard in 2004.

Box 3: Key Features of Zero-Carbon Eco-town Development in the UK

The proposed zero-carbon eco-town development project will adopt a series of energy-efficiency technologies such as combined heat and power, district heating and cooling systems and aquifer thermal energy. None of these technologies is very new, but the eco-town project would adopt these technologies at the same time and at the city level to produce enough on-site energy resources for the city's energy consumption. Key technologies of the zero-carbon eco-town development project include:

Combined Heat and Power

Combined heat and power is a fuel-efficient energy technology that, unlike conventional forms of power generation, puts to use the by-product heat that is normally wasted. Combined heat and power can increase the overall efficiency of fuel use to more than 75 per cent, compared with around 50 per cent or less from conventional electricity generation.

District Heating and Cooling Systems

District heating is a system for distributing heat generated in a centralized location for residential and/or commercial heating requirements. District heating systems distribute steam or hot water to multiple buildings. The heat can be provided from a variety of sources, including geothermal, combined heat and power plants, waste heat from industry, and purpose-built heating plants.

Aquifer Thermal Energy

Aquifer thermal energy storage uses underground water reserves. There are two wells (typically) on either side with hydraulic coupling. One well is for the warm water and the other one is for the cold. In the winter, warm water is used for heating and passed to the cold well. Energy is extracted by a heat exchanger for heating purposes. In summer, the process is reversed and cold water is used for cooling.

Ground Source Heat Pumps

Ground source heat pumps transfer heat from the ground into a building to provide space heating and, in some cases, to pre-heat domestic hot water.

Solar Energy

Solar energy can be used in a number of ways to provide energy. Passive solar energy is the use of sunlight to keep buildings warm through the direct warming effect of the sun on a building, eg via walls and glazing. Thermal solar panels provide space heating and hot water. Another method is to convert solar energy to electricity in photovoltaic cells.

Source: The Department of Communities and Local Government, the UK Government, See: http://www.communities.gov.uk

In addition to standards, Asian governments have been strengthening their regulatory and non-regulatory policies to promote higher efficiency buildings in recent years (see Part III for more detailed information). More regulations in this region are expected in the coming years.

Besides the clear trend of increased regulation, Asian governments are constructing demonstration and model buildings to raise awareness and showcase best practices. The CII-Godrej Green Business Center Building in India, a joint initiative of the Confederation of Indian Industry (CII) and Godrej, is a LEED-Platinum-certified building which is capable of 55 percent reduction in total energy consumption and

Box 4: Energy Service Companies

According to the U.S. Department of Energy, an ESCO, or energy service company, is a business that develops, installs, and finances projects designed to improve energy efficiency and reduce operations and maintenance costs for its customers' facilities. Typically, ESCOs offer the following services:

- develop, design, and finance energy efficiency projects;
- install and maintain the energy efficient equipment involved;
- measure, monitor, and verify the project's energy savings; and
- assume at least some financial risk that the project will save the amount of energy guaranteed.

What sets ESCOs apart from other firms that offer energy efficiency, like consulting firms and equipment contractors, is the concept of performance-based contracting. When an ESCO undertakes a project, the services it provides are bundled into the project's cost and are repaid through the savings generated. Therefore, the company's compensation is directly linked to the amount of energy that is actually saved.

The concept of ESCO's originated in the U.S. and Canada in the late 1970s and early 1980s and is now fairly well-established in the U.S. and Europe. Typically, energy efficiency projects require a large initial capital investment. With ESCOs offering a variety of contract options, guaranteeing the performance and assuming the risk (technical, operational and financial), they have become an ideal vehicle for companies to implement energy-efficiency improvements, and the ESCO market has grown rapidly in the U.S. in the past decade. According to the U.S. National Association of Energy Service Companies, projects of around US$20 billion have been installed by ESCOs in the U.S. to date.

In addition to the economic and environmental benefits realized by ESCO customers through energy and maintenance cost savings, new jobs have been created. The U.S. National Association of Energy Service Companies estimated that ap-

88 percent reduction in lighting energy consumption. Other notable examples include China's Agenda 21 Demonstration Energy-Efficient Office Building in Beijing, which is the headquarters building of the Ministry of Science and Technology; Malaysia's Low-Energy Office Building (LEO), which is the headquarters building of the Ministry of Energy, Water and Communications; and Singapore's Revenue House, which is the headquarters building of the Inland Revenue Authority of Singapore (see Part II for these and other cases).

Increased environmental concerns increasingly are also reflected in Asia's commercial market. By the end of August 2006, China and India

Box 4 Continued

proximately one-third of the US$20 billion invested in ESCO projects, or around US$7 billion, has been spent on labor costs.

In Asia, the ESCO sector is relatively underdeveloped. The ESCO market in this region is mainly supported by international funds from organizations such as the World Bank, Asia Development Bank, and the Renewable Energy and Energy Efficiency Partnership (REEEP). For example, REEEP is backing a number of ESCOs projects in Asia. In rural India, REEEP is working to establish an ESCO in order to create a commercially viable market for solar photovoltaic technologies to serve rural areas. In the Philippines, REEEP is working to facilitate affordable financing for small-scale energy efficiency projects using ESCOs as financing intermediaries. In western China, where electricity demand is growing rapidly, REEEP is promoting energy efficiency by transferring successful programs from those areas which have already benefited from energy efficiency through the establishment of networks of ESCOs.

Some Asian countries are promoting the ESCO concept through providing funds and subsidies to ESCOs and implementing demonstration ESCO projects to jump-start the market by demonstrating the effectiveness of this form of financial assistance. The Japanese government has been providing subsidies to ESCOs to enable them to provide competitive energy services. In Thailand, the energy retrofit of the Mike Shopping Mall is a demonstration ESCO project supported by the Thai government. The project won an ASEAN energy award in 2001 (see Part II for details of this case).

Source: The U.S. National Association of Energy Service Companies, see: http://www.naesco.org/; the U.S. Department of Energy, see: http://www1.eere.energy.gov/; the European Bank for Reconstruction and Development, see: http://www.ebrd.com; Asia Development Bank, see: http://www.adb.org/

had a total of 11 LEED-certified buildings; seven of them were built by for-profit companies (see Table 1). The TaiGe serviced apartments in Shenzhen, China is the first LEED-certified commercial building in the country. It was developed in 2004 by China Merchants Property Development Co., Ltd., a subsidiary of China Merchants Group Ltd. The building can save 75 percent of lighting power consumption and 50 percent of air-conditioner power consumption per square meter per hour compared with hotels to achieve the same brightness and temperature. This building cost more to build but rents at a premium and has a waiting list to get in.

In Taiwan, the Taipei Metro complex developed by the Far Eastern Group incorporated a series of energy-efficiency measures and that have allowed it achieve savings of around TWD$20 million (around US$ 610,000) in energy bills every year. In South Korea, the office building of the Kolon R&D Institute of Technology, the central research institute of the Kolon Group, adopted environmentally friendly measures and reduced energy costs by more than 50 percent.

Asian governments and companies are also exploiting the possibility to build buildings and even cities that are carbon-neutral. In China, the Pearl River Tower, which has been under construction since 2006 in Guangzhou and will be occupied by the China National Tobacco Corporation, is designed to be one of the first zero-energy buildings in the world. This 69-story, 303-meter tower takes advantage of both high energy-efficiency building design and solar and wind power to generate energy. In Shanghai, the Dongtan Eco-city is envisioned to be as close to carbon-neutral as is economically possible. It is a public-private partnership and is already in the design phase.

Not only are companies constructing new green buildings, they are also retrofitting existing buildings to improve their efficiency. In the Philippines, the 35-year-old Makati Stock Exchange Building of Ayala Land Inc. underwent continuous energy-efficiency upgrading from 1996 to 2005. Total savings generated by these improvements have reached more than US$126,000 per year.

In Indonesia, the Plaza BII Building retrofit project achieved a reduction of 22 percent in energy consumption and won the ASEAN Energy Award (Retrofitted Building Category) in 2005. In Hong Kong, an energy-efficiency retrofit of the Swire Group's office buildings Cityplaza (III& IV) achieved annual electricity savings of around HK$ 1 million (about US$128,000). The investment payback period is approximately 3 years.

In Singapore, the Keppel Group has been implementing energy-efficiency measures in the Keppel Bay Tower, a three-year old office building, since early 2007. The targeted saving is 14 percent in electricity consumption, or SGD$136,000 (more than US$90,000) per year, with a payback period of around 2.2 years (see Part II for these and other cases).

On the demand side, driven by increased concern over environmental degradation and rising energy prices, sophisticated tenants, investors and home buyers are increasingly showing a preference for buildings that incorporate environmentally friendly features. For example, property investors and fund managers want better environmental performance as energy efficiency has been introduced into building codes and Asian economies are establishing energy performance rating systems that show product differentiation. Tenants are increasingly recognizing that environmental performance has a direct impact on their corporate image and energy efficiency creates direct financial benefits. And for home buyers, high-efficiency building means lower electricity bill and healthier indoor environment. Slowly but surely, "green" is becoming one of the elements of building features used to lure consumers.

Taken together, these factors are likely to have far-reaching effects in the way buildings are designed, constructed, and used in Asia.

Table 1: LEED-Certified Projects in China and India (as of August, 2006)

CITY	PROJECT NAME	RATING	CERTIFIED DATE	SIZE (M^2)	PROJECT TYPE	OWNER	OWNER TYPE
CHINA							
Suzhou	Plantronics Factory	Gold	April 06	150,600	Industrial	Plantronics	Private
Suzhou	Plantronics Office	Silver	April 06	64,500	Commercial Office	Plantronics	Private
Beijing	Energy Efficiency Demonstration Project of Ministry of Science and Technology	Gold	July 05	139,000	Commercial Office	Ministry of Science and Technology	Government
Shenzhen	TaiGe Service Apartments	Silver	September 05	280,090	Commercial Residential Apartment	China Merchants Property Development Co. Ltd.	Private
Harbin	Lesong Mall	Silver	November 05	861,100	Retail	Harbin Ha Dian Real Estate Co.,Ltd	Private

INDIA							
Chennai	Grundfos Pumps India	Gold	May 05	25,000	Other	Grundfos Pumps India Pvt Ltd.,	Other
Sholinganallur	NEG Micon (India) Private Ltd.	Gold	September 05	17,750	Commercial Office	NEG Micon	Other
Hyderabad	CII-Sohrabji Godrej Green Business Center	Platinum	October 03	17,000		Confederation of Indian Industry	Private
Gurgaon	ITC Center Project	Platinum	October 04	170,000	Multi-use	ITC Limited	Private
Gurgaon	Gurgaon Development Center, Wipro Ltd	Platinum	August 05	120,000	Other	Wipro Technologies	Private
Kolkata	Technopolis	Gold	---	498,901	Other	Phoenix Software Limited	Private

Source: E-mail correspondence with the U.S. Green Building Council, September, 2006.

What Makes Buildings Energy Efficient?

The basic tenet of building energy efficiency is to use less energy for heating, cooling, and lighting, without affecting the comfort of those who use the building. High-performance buildings not only save energy costs and natural resources, but also mean a higher-quality indoor environment. The benefits of building energy efficiency include:

Reduced Resource Consumption

Improving building energy efficiency as a new energy supply significantly reduces demand for new oil supplies and new power plant investment.

Minimized Life-cycle Costs

Improving building energy efficiency reduces the amount of energy required to operate a building, and reduces costs for building occupants.

Reduced Environmental Impact

Buildings contribute to the discharge of four primary pollutants---mono-nitrogen oxides (NO_X), sulfur oxide (SO_X), CO_2, and particulates. Improving building energy efficiency reduces the need for fossil fuels and reduces greenhouse gas emissions.

Healthier Indoor Environment

Efficient buildings also mean a healthier indoor environment for the people who live and work in them by, for example, using pleasing architectural designs to brighten up work areas using sunlight rather than electricity, without causing excess glare. Comfortable temperatures and a quiet work environment are also features of high-performance buildings.

Increased Employee Productivity

Improved comfort of building occupants contributes to increased employee productivity. Recent studies have shown an increase in employee productivity when buildings have features such as natural light, better control of temperature, and more intelligent use of space.[25]

Diverse Stakeholder Perspectives

Options for improving energy efficiency and the principal stakeholder responsible for that improvement depend significantly on the kind of structure in question. For new buildings, design is a key driver of energy performance, with developers the key decision-makers affecting a building's design and efficiency. For existing buildings, how a property is operated and how its occupants use the space are the key determining factors for energy consumption.

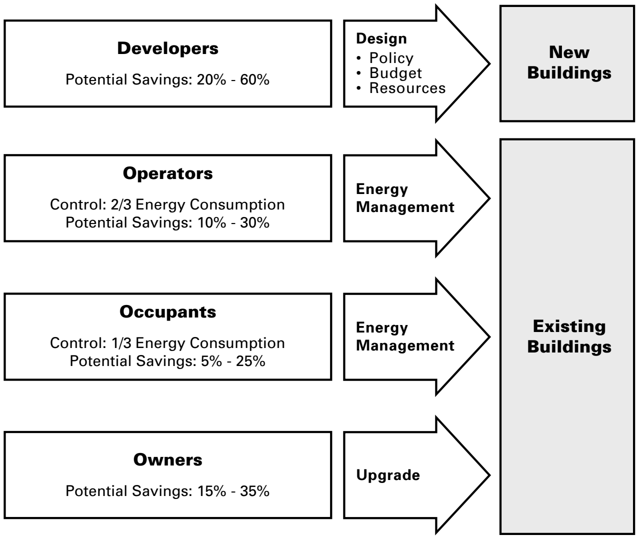
Stakeholders have different financial and other objectives associated with any particular property, but each shares in the collective ability to shape energy demand (see Figure 6). At the same time that they are realizing gains on their investments, developers have the greatest influence over the energy performance of new buildings by controlling project objectives, design expertise and budget. Building owners also have a significant impact on current and future energy efficiency of existing buildings by selecting, or directing management resources toward, more energy-efficient building maintenance and upgrades.

Building operators aim to enhance a building's attractiveness to commercial or residential tenants, while keeping the cost of services and maintenance as low as is competitively possible to maximize their profits as the management fees are usually fixed. They have direct responsibility for a building's common energy services, which together typically account for the majority of a modern commercial building's energy consumption.

Building occupants strive to find the most cost-effective and comfortable space suited to their business or residential needs. Their scope of influence on energy consumption is primarily through conservation efforts and good choices in energy consuming equipment.

Notwithstanding their different perspectives, developers who mandate energy-efficient designs, building operators who employ effective management practices, and educated, energy-conscious tenants can significantly reduce energy consumption of buildings, if working together toward a common objective (see Figure 6).

Figure 6: Key Influences on Building Energy Consumption



Note: Control refers to the typical energy consumption split between owner and tenant in a modern air-conditioned commercial building. Ranges based on Asia Business Council interviews and secondary sources.

- For new buildings, cases have shown that energy savings of 20 to 70 percent are possible through energy-conscious design.[26]
- For existing buildings, operators are using energy management as a service differentiator and routinely reducing energy consumption by 10 to 30 percent; commercial business occupants are using energy management in buildings they lease to improve their cost structure, enhance company reputation and motivate staff, and are able to achieve 5 to 25 percent savings in energy consumption; and owners through building upgrading and renovation have shown 15 to 35 percent energy savings. In sum, the efforts by all stakeholders are capable of 25 to 50 percent of energy savings for existing buildings.

New Building Design: A Cost-Effective Opportunity

It is far more cost-effective to build energy efficiency into the design of a new building than to retrofit an existing building, because a new building offers flexibility in all its construction parameters. In Asia, where the majority of the world's new construction will take place over the next decade, there is tremendous opportunity to use smart, energy-efficient designs to reduce the energy footprint of the built environment for decades to come.

Around Asia, governments are sponsoring demonstration projects to raise awareness of the benefits, techniques and technologies of energy-efficient design, and these projects have shown energy savings up to 60 percent. For example, the new headquarters building of the Ministry of Science and Technology in China, also named the Agenda 21 Demonstration Energy-Efficient Office Building, achieved LEED Gold certification in 2002, and is China's first LEED-certified building. Building construction costs were comparable to conventional buildings and were achieved through the use of lower-cost building components. Energy consumption is estimated at 60 percent less than comparable buildings. In Japan, the Osaka Municipal Central Gymnasium saves 31 percent of annual electricity consumption compared with the building energy standard in Japan, which is already higher than other Asian countries.

In Southeast Asia, Association of Southeast Nations (ASEAN) countries have boosted interest in energy-efficient buildings with the ASEAN Energy Awards (see Box 5). Malaysia's Low-Energy Office Building (LEO), the new headquarters building of the Ministry of Energy, Water and Communications in Putrajaya, won the ASEAN

Box 5: Winners of ASEAN Energy Awards (Energy-Efficient Buildings)

The first ASEAN Energy Awards (AEA) for energy-efficient buildings was launched on July 2, 2000 by the ASEAN Energy Cooperation and the ASEAN Center for Energy (ACE). The objectives of the awards are to "promote regional cooperation in various fields of energy such as energy efficiency and conservation;" and to "serve as a platform to generate opportunities and interests of the private sector to be involved in energy development of the ASEAN region in partnership with the public sector." The awardees of the AEA for Energy Efficient Buildings were chosen through the ASEAN Energy Efficiency and Conservation (EE&C) Best Practices Competition.

2006 Winners

- New and Existing Building: LEO Building, Malaysia
- Retrofitted Building: Tan Tock Seng Hospital Building, Singapore
- Tropical Building: Clark Quay Building, Singapore
- Special Submission: Water Jet Nozzle to Reduce the Operation Cost in Air Conditioning Unit of Atma Jaya Catholic University, Indonesia

2005 Winners

- New and Existing Building: National Institute of Education Building, Singapore
- Retrofitted Building: Plaza BII Building, Indonesia
- Tropical Building:
  —Posa Mountain Resort Building, Myanmar
  —Singapore Botanic Garden Building
- Special Submission: Environmental-Friendly Solar Hydrogen Eco-House, Malaysia

2004 Winners

- New and Existing Building: Nanyang Polytechnic Building, Singapore
- Retrofitted Building: Royal Plaza on Scotts Building, Singapore

Energy Award in 2006. The building, which cost 10 percent more than traditional office buildings to construct, has been occupied since September 2004 and has been documented to use only 42 percent of the energy of a typical similar building in Malaysia. The 2000 award winner was Revenue House, headquarters of the Inland Revenue Authority of Singapore. It is the first of a new generation of intelligent buildings designed and built by Singapore's Public Works Department.

Box 5 Continued

- Tropical Building: Natural Resort and Spa Building, Indonesia
- Special Submission
  - —Esplanade-Theatres on Bay Building, Singapore
  - —Bio Solar House Building, Thailand
  - —Air Conditioning Unit Equipped with Heat Pipe for Tropical Climate Building, Indonesia

2003 Winners

- New & Existing Building: Central Academic Shinawatra University Building, Thailand
- Retrofitted Building: Grand Hyatt Regency Hotel Building, Singapore

2002 Winners

- New and Existing Building: Changi General Hospital Building, Singapore
- Retrofitted Building: Shangri-la Hotel Building, Singapore
- Special Submission:
  - —Cutting Edge Technology: Sutera Harbour Resort Building, Malaysia; Changi Naval Base Building, Singapore
  - —Appropriate Technology: Kanbawza Bank Headquarters Building, Myanmar

2001 Winners

- New and Existing Building: Securities Commission Building, Malaysia
- Retrofitted Building: Mike Shopping Mall, Thailand
- Special Submission: Fort Bonifacio Development Corporation Office Building, Philippines

2000 Winners

- Regional Winner: the Revenue House, Singapore

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_organisations/eec_ssn/eec_ssn.htm

Completed in 1996, it consumes about 30 percent less energy than an average building of its size.

Non-government green building projects around the region also showed similar percentages in energy savings. For instance, the Fort Bonifacio Development Corporation Office Building E in the Philippines consumes 50 percent less energy than ordinary buildings. This Building won the ASEAN Energy Award in 2001 (Special Category). In China, the TaiGe serviced apartments can save 75 percent of lighting power consumption and 50 percent of air-conditioner power consumption compared with hotels to achieve the same brightness and temperature (see Part II for the cases).

Integrated and Passive Design Key to Energy-Conscious Buildings

Developers who take the energy performance of new construction seriously are using integrated and passive design techniques to maximize energy efficiency.

Integrated Design Approach

Building developers can select energy-saving components, such as specially-glazed windows that let in daylight without raising the temperature, and high-efficiency heating, ventilation, and air-conditioning (HVAC) options, but if the building is not designed to optimize the interaction of these components with its structural characteristics and the natural environment, energy performance will be sub-optimal (see Box 6). In fact, a building is a complex system with its components interacting with each other. All the building components must work together as a system to save energy while keeping a building warm in cool environments and cool in warm environments.

"The whole is greater than the sum of its parts." To effectively optimize the interactions between the natural environment, building envelope and systems, experts point to the necessity of an integrated design approach, or whole-building design approach, which asks all the members of the planning, design, construction, and operation team to look at the project objectives, site, building materials, building components, and the construction process as an integrated system, and examine how these components work best together to save energy and reduce environmental impact. This approach deviates from the typical traditional planning and design process that relies on the expertise of specialists who work in their respective areas but are relatively isolated from each other.

For example, one of the key strategies for efficient building envelopes is the integration of design and window strategies to bring daylight into a building's interior without heat and glare. Designs that make extensive use of day lighting reduce the need for artificial light. Use of high-efficiency lighting (e.g. compact fluorescent) reduces both electricity demand and heat gain, which in turn means that designers can select smaller cooling systems. The cumulative energy savings from an integrated design ends up being greater than if energy-saving features are implemented individually. The whole process requires an interactive cycle of modeling, testing and trade-offs to yield the most cost-effective energy performance.

According to William Browning, a senior fellow at the Rocky Mountain Institute in Colorado,

Box 6: Building Components

For new building design, the choices of which kinds of building components and systems to use can either enhance or degrade the energy efficiency of a building.

The building envelope is a major component in determining a building's energy use. It includes everything that separates the interior of the building from the outdoor environment: the doors, windows, walls, foundation, roof, and insulation. Various approaches can help improve the building envelope. For example, storm windows and doors can reduce heat loss when temperatures drop. In warm regions, windows with special glazing can let in daylight without raising the temperature.

Other critical building components include HVAC, lighting, and appliances and equipment occupants use in the building. Today, most common appliances and equipment—from refrigerators to copiers and computers—are available in energy-efficient models.

integrating green principles can generate 40 percent more savings and 40 percent better performance than simply adding green technologies to a traditionally planned and designed facility.[27] Savings estimates presented at an International Energy Agency conference in late 2006 show similar findings. According to David Goldstein, energy program director of the National Resources Defense Council, an average of 25

Box 7: Elements of Passive Design

Analyzing Climate and Site: The key to passive design is to make the most use of the natural environment. Passive design responses for buildings vary in accordance with the climate and site conditions.

Orientation: A building that is well-positioned on its site delivers significant lifestyle and environmental benefits. Appropriate orientation assists passive heating and cooling, resulting in improved comfort and decreased energy bills.

Passive Solar Heating: Passive solar heating keeps heat from the summer sun out and lets heat from the winter sun in.

Passive Cooling: Passive cooling uses design and modification of buildings to achieve summer comfort and minimize or eliminate energy use for cooling.

Insulation Installation: Insulation is an essential component of passive design. It improves building envelope performance by minimising heat loss and heat gain through walls, roof and floors.

Thermal Mass: Externally insulated, dense materials like concrete, bricks and other masonry are used in passive design to absorb, store and re-release thermal energy. This technique moderates internal temperatures by averaging day/night (diurnal) extremes, therefore increasing comfort and reducing energy costs.

Windows and Glazing: Windows and glazing are very important because heat loss and gain in a well-insulated building occurs mostly through the windows. For the design of windows, cooling breezes and air movement are encouraged in summer and cold winter winds are excluded. Glazing is used to trap winter heat whilst excluding summer sun.

Shading: Shading of glass is also critical, since unprotected glass is the single greatest source of heat gain in a well insulated home. Shading requirements vary according to climate and house orientation. In climates where winter heating is required, shading devices should exclude summer sun but allow full winter sun to penetrate. In climates where no heating is required, shading of the whole home and outdoor spaces will improve comfort and save energy.

Skylights: Well-positioned and high-quality skylights can improve the energy performance of the building and bring welcome natural light to otherwise dark areas.

Source: Australian Greenhouse Office, see: http://www.greenhouse.gov.au/

percent savings and a three-year payback is attributed to "bolt-on" technologies (high-efficiency components such as HVAC or lighting added to an existing building design). However, he estimates a 50 percent savings at no increase in initial costs for integrated design of energy-efficient features.[28]

In Singapore, the headquarters of the Urban Redevelopment Authority has used the integrated design approach to achieve high standards of acoustics, visual and thermal comfort, air and spatial quality, and energy efficiency. The building was a runner-up in ASEAN Energy Awards (2001). In China, the Agenda 21 Demonstration Energy-Efficient Office Building also used the integrated design approach to identify the most cost-effective energy strategies (see Part II for these cases).

Passive Design

Passive design is design that takes advantage of natural energy flows to maintain a building's thermal comfort, and reduces the need for mechanical heating or cooling. Buildings that are passively designed maximize cooling air movement and exclude sun in summer, and trap and store heat from the sun and minimize heat loss to the external environment in winter (see Box 7).

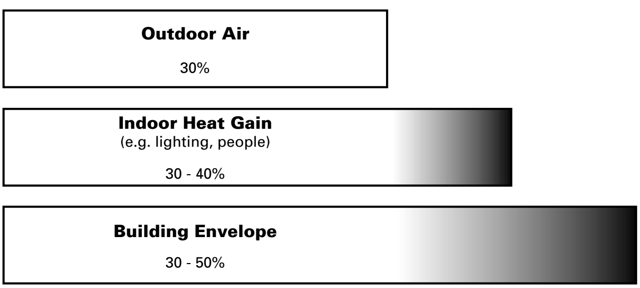
A number of passive options are available when designing the building envelope. These may include increased use of glazing, double glazing with coating to reduce solar radiation transmission, curtain wall panel/frame insulation, external canopy/fin shading. According to Victor Leung of Hysan Development in Hong Kong, envelope design is a major factor in determining the amount of energy a building will use in its operation. In his own experience, Leung notes that energy-efficient envelope design for commercial buildings may contribute up to a 50 percent reduction in external heat gain during hot Hong Kong summers (see Figure 7). The Sunny Bay MTR station in Hong Kong, for example, operates on minimal energy because it has no air conditioning, instead making use of the natural environment to control the temperature and lighting inside. This project won the Hong Kong Institute of Architects Merit Award (2005) and the Green Building Grand Award (2006) from Hong Kong's Professional Green Building Council. In Malaysia, the Securities Commission Building has made good use of passive design and won the 2001 ASEAN Energy Awards. In Taiwan, the newly built Beitou Library is also a green building that uses passive design to maximize daylighting and natural ventilation (see Part II for these cases).

Obstacles to Enhancing Energy Efficiency in New Construction

For much of the building industry in Asia, this designed-in approach to energy-efficient design does not reflect current market practice. In reality, most such opportunities for designing better-performance buildings are wasted. In Asia's urban centers, most new construction is climate-rejecting. Joseph Deringer, scientist at White Box Technologies, a sustainable energy design consultancy in Berkeley, and technical advisor to this study, commented that "Designers just seal up the building and add air conditioning."

Interviews with architects, developers and efficiency experts suggest that several factors—perceived and real—slow the uptake of energy-ef-

Figure 7: Factors Affecting a Building's Heating/Cooling Loads



Note: Ranges are for a commercial building and are based on the Hong Kong climate. The actual impact varies with climate and season.

Source: Asia Business Council Interviews.

ficiency measures in designing and constructing new buildings:

- Increased capital costs for construction;
- Compressed development schedules in most of the region's rapidly developing countries;
- Excess capacity of HVAC systems because of insufficient expertise by designers;
- Poor quality of commissioning;
- Lack of life-cycle cost thinking;
- Lack of trusted energy-efficiency rating and verification systems; and
- Limited awareness or skills leading to efficient energy use in new buildings.

Perceived Increased Costs

One of the greatest impediments to the broader-based adoption of energy-efficient building practices is the perception that more efficient buildings cost significantly more to build. A growing body of literature and case studies on green buildings shows this perception is unfounded. Green buildings not only achieve energy efficiency but do so economically.

A recent review of international research on the costs and benefits of green buildings conducted by the Green Building Council of Australia concluded that the general international consensus is that green buildings cost about 2 percent more to design and construct.[29] In a U.S. report examining construction costs of 138 buildings across the country, of which 45 had been certified as green, the research concluded that there was no statistically significant difference between the capital costs of green and conventional buildings.[30]

Numerous studies from the U.S., Canada and Australia show that green buildings provide a number of hard and soft benefits for both commercial building developers and owners/occupants during buildings' life cycles (see Table 2).

In Asia, reported results for buildings in India and China where developers have chosen to rate their buildings using the U.S. Green

Building Council LEED system provide some indication of the costs of high-efficiency buildings. [31] In India, results reported for five LEED-rated buildings show the following characteristics:[32]

- Energy savings: 30 to 40 percent;
- Water savings: 20 to 30 percent; and
- Construction cost premium ranging between six and 20 percent with a payback range of three to seven years.

According to Kenneth Langer, president of the international consulting firm EMSI, all of the more than 20 large green building projects his firm has worked on in China have come in under a five-year simple payback period and under a five-percent incremental capital cost. These projects all involved pursuing or achieving LEED certification.

These initial cost references suggest that the green premium in Asia is somewhat higher than in the more developed countries. Asia Business Council interviews revealed that the higher cost is attributed, in part, to higher materials costs and inexperienced design teams. Joe

Table 2: Economic Benefits of Green Buildings

FOR COMMERCIAL BUILDING DEVELOPERS	FOR OWNERS/ OCCUPANTS
Market differentiation	Improve public image
Improved occupancy rates: 3.5 percent higher	Up to 60 percent reduction in water and energy consumption
Higher rents: 3 – 10 percent higher	Increased employee satisfaction and productivity: up to 25 percent annually
Increased asset value: 7.5-10 percent premium	Increased asset value: 7.5-10 percent premium
Improved return on investment: up to 6.6 percent	

Sources: data based on Green Building Council Australia, 2006, "The Dollars and Sense of Green Buildings 2006: Building the Business Case for Green Commercial Buildings in Australia", see: http://www.gbcaus.org/gbc.asp?sectionid=15&docid=1002; Charles Lockwood, 2006, "As Green as the Grass Outside", Barron's, *December 25, see: http://www.charleslockwood.com/pdf/barrons_article.pdf*

Huang, scientist at Lawrence Berkeley National Laboratory and technical advisor to this study, said about green buildings in China, "In terms of the economics of green buildings, there is probably more of a price premium than in the more developed countries simply because current standard of construction in China is at a lower technical level than that demanded by most green building rating schemes."

In general, evidence suggests that it is possible to build energy-efficient or green buildings with little or no capital cost premium but these cost figures are typically the net result of an increased expenditure on certain components (e.g. windows, HVAC systems) with offsetting savings achieved through careful design. Achievement of these types of savings depends largely on the integration and skills of the design team.

Compressed Construction Schedules

It is a common practice in the building industry in Asia for design and construction to occur independently and often at the same time. Many developers rely on standard formulas and re-use design elements from building to building. They often incorporate design variables late in the process, so that different parts of the construction process can overlap to speed construction. As a result, building systems may not be considered until later in the process and are fit into the existing structure. According to John Burnett, chair professor of Building Services Engineering at the Hong Kong Polytechnic University: "There is tremendous pressure to build quickly; often construction and design are happening at the same time. The result is 'quick and nasty' design based on rules-of-thumb. There is little time for analysis and some of the details get missed."

Designers must meet developers' needs in the most reasonable and time-efficient manner and with short development time frames; this reality often means off-the-shelf design with only aesthetic changes. Because there is often not a mandate to start from the ground up, envelope properties and building systems are not customarily tailored to the building and, thus, their interactions are not optimized.

Excess Capacity of HVAC Systems

Another result of short design times is that HVAC systems frequently are bigger than needed, thus using more electricity. The HVAC system in many regions is the largest energy-consuming system, accounting for up to 60 percent of energy consumption in modern commercial buildings. Often, these systems are massively oversized because designers seldom take into consideration how the building will be operated or the interaction with other building systems (e.g. lighting). As Liu Junyue, vice chief and chief engineer at the Shenzhen Building Research Institute, put it, "Building energy-efficiency design is not art, it is a science. It is most cost-effective if efficiency is considered at the very beginning of the design stage but in practice it happens much later and, as a result, it is common that mechanical systems are 30-50 percent larger than they should be."

From the engineer's perspective, using a larger HVAC system is a much lower risk than using a smaller one. Joe Huang shared an anecdote from his work on the new headquarters building of the Ministry of Science and Technology in Beijing. Although Huang's detailed computer modeling showed that a 550 KW chiller would be sufficient for the proposed building, the project engineer, using common Chinese design software, proposed a chiller nearly double that size. Even though the engineer personally believed that the smaller chiller size was more rational, he would not specify it for fear of liability if the building were to overheat. The building owner broke the impasse by agreeing to sign a letter approving the smaller HVAC system, absolving the engineer of responsibility for that decision. That allowed the engineer to employ the smaller system, which has been shown to have no capacity-related problems in the three summers since the building was completed in 2004.

According to Hong Kong-based Hysan Development, one of the key strategies for optimizing HVAC system design is to involve the building operator early in the design stage so that building systems are designed specifically to meet the expected load profile and provide necessary flexibility. However, this issue of operator participation is particularly problematic for the developers when building end-use may not be well fixed, as is common in Asia's rapidly developing countries.

Poor Quality of Commissioning

Commissioning quality is hampered by compressed time frames as well as a lack of design consideration. Commissioning refers to the process of verifying that a building performs in accordance with the design intent, contract documents and the owner's operational needs. In addition to verification, the commissioning process should include documentation of operating procedures and training of operators to enable a smooth building handover.

According to industry interviews, in Asia commissioning (or T&C for testing and commissioning) is more of a sign-off that systems work than a quality control process; it is not uncommon for testing procedures to go unverified, or for T&C reports to be signed with only a cursory review. John Burnett noted, "Commissioning is meant to be a quality control process, yet most of it happens at the end of the build rather than during the process." Required commissioning design details, such as testing valves for water or air conditioning, may not be included. The quality of operation and maintenance manuals and staff training are often poor, due to pressure from the tenant to occupy the building and few or lax penalties for poor vendor performance. Use of independent commissioning agents is not common.

But the increasing sophistication of building designs and complexity of building systems is driving the need for increased attention to commissioning. This is particularly true of energy-efficient buildings where HVAC systems are less likely to be oversized and must therefore run as intended to achieve desired comfort levels.

The U.S. Department of Energy reports that the operating costs of a commissioned building range from 8 to 20 percent below those of a non-commissioned building as a result of energy and water savings.[33] Case studies in the private sector compiled by the U.S.-based Betterbricks, an initiative of the Northwest Energy Efficiency Alliance, a non-profit supported by electric utilities throughout the Northwest, show that commissioning can improve new building energy performance by 8 to 30 percent and that quality commissioning can pay for itself and should be considered by owners and operators.[34]

Limited Expertise in Energy Efficiency

Knowledge of energy-efficiency concepts and related skills are limited across the building industry in Asia. Hu Jianxin, the deputy general manager of China Merchants Property Development, led the successful development of TaiGe serviced apartments in Shenzhen, China. The LEED-rated service apartment is a financial success, but Hu acknowledged that the whole process was painful. He said, "It was very difficult to find qualified experts and consultants to help with the energy-efficiency building design. It was [also] difficult to find a qualified construction company to build the building, and a qualified property management team to operate and maintain the building." This lack of expertise in the industry poses a challenge to energy efficiency.

Often, developers rely heavily on their engineering consultants for the energy-efficiency performance in their projects. In more mature markets, however, developers have deeper expertise and they take a greater leadership role in the design of new properties. This same level of knowledge on the part of developers is necessary to drive energy efficiency.

Lack of Life-Cycle Cost Thinking

First-cost analysis only takes into account the costs to design and construct a building. The prevalent use of first-cost analysis in the Asian building industry frequently ignores energy-saving gains during a building's life cycle and results in decisions that overlook the opportunity for long-term financial returns in the form of greater efficiency.

When owners use a life-cycle cost analysis, they take into account more than just the costs of design and construction, but also include the long-term operations, maintenance, repair, replacement, and disposal costs of a structure. Life-cycle costs are the sum of initial and future costs associated with the construction and operation of a building over a period of time. Life-cycle cost analysis provides a framework for considering environmental and economic costs over the whole life of a building.

Lack of Trusted Energy-Efficiency Rating and Verification System

Developers are often reluctant to invest in design elements, systems features or commissioning to lower operating costs because they are not usually the ones who ultimately pay the energy bill and the current market has a limited ability to value those investments in the form of increased asset prices. Global efforts to develop methods to rate building energy performance, and the green building movement, are expected to make it easier for developers to place value on superior energy performance. But in markets that do not yet certify or rate building energy performance, energy-efficiency investments will remain hard to verify and value.

Energy Management of Existing Buildings

> *"The adoption of environmentally friendly practices has played a more critical role in leasing decisions among multinational corporations that desire buildings with safe and healthy environments and features that will save energy, reduce waste, and increase productivity".*
>
> — Managing Properties Today: Industry Trends and Cost-savings Strategies, *Jones Lang LaSalle*, December 2005.

Despite rapid rates of construction in Asia, existing building stock far exceeds that added annually. In China, for example, new buildings represent just five percent of the built footprint per annum. Even if all new buildings achieve the energy-saving target of 50 percent, that reduction will still be small relative to the energy consumption of the existing stock. In the short- to medium-term, the greatest opportunity for realizing increased building energy efficiencies will be through good management practices of building operators, enhanced energy-saving behavior of the individuals occupying these buildings and cost-effective building upgrades by owners.

Contrary to popular perception, industry interviews and research confirm that many energy-saving initiatives for existing buildings can be achieved with little or no cost. For example, Festival Walk in Hong Kong, a mixed-use commercial complex building built and managed by Swire Properties, one of the biggest real estate companies in Hong Kong and a member of the Swire Pacific Group, changed the control strategy of its air conditioning system in 2004 from a flow-demand oriented logic to a multi-criterion logic to minimize the mismatch of cooling load demand and chilled water flow demand. The investment for such a change was minimal since it only required modification of the program logic, but the energy savings reached approximately 400,000 kWh and reduced the release of CO_2 by 240,000 kg annually (see Part II for the case).

To identify such saving opportunities like the Festival Walk case in existing buildings, the starting point is to make energy management a business priority for building operators and occupiers.

Energy Management Adds Value

> *"Energy management is not a technical issue, it's a management issue. If a company does not bring together the managerial aspects of the program they are just dabbling at the edges."*
>
> — Robert Allender, Managing Director, Energy Resources Management[35]

Energy management is the foundation of efficient energy use in existing buildings. While the scope of energy management activity varies by company, the concept generally refers to structured efforts to improve conservation and efficiency as well as consideration of appropriate tariff and energy types. It is gaining acceptance as companies around the globe seek ways to address competitive cost pressures, enhance environmental performance and corporate reputation, and reduce risk. Companies that practice good energy management not only enhance their bottom line, but also lessen the energy consumption footprint where they operate.

Research in the U.S. has shown that energy savings achieved through energy management programs typically range from five to 20 percent without any capital investment. In Asia, results reported in Asia Business Council interviews fall within the upper end of that range.[36]

Factors Critical to Successful Energy Management in Asia: An Asia Business Council Survey

In 2006, the Asia Business Council surveyed 17 energy managers from around the region, including representatives from banking, property management, and industrial and manufacturing industries to find out which factors are critical to creating a successful energy management program. The survey was done in two parts: first, the Council asked energy managers to rate a set of common energy management practices for their importance and then Council research staff conducted follow-up interviews. Survey responses mirror studies on best practices from the West and reaffirm that good energy management practices do not differ appreciably around the globe (see Figure 8).

Senior Management Support

One of the most significant survey findings is that all respondents think effective energy management requires the support of senior management. In most cases where companies believe they have effective programs, the CEO or chairman heads the energy management committee, receives regular reports and participates in the setting of energy performance targets. Nearly every company surveyed had written policies regarding energy management, an important indicator of management commitment in setting direction. Some were separate policies and others were a component of a broader environmental policy. Some policies included specific energy reduction targets, while others outlined the company's commitment and/or approach to reduced energy use.

Education a Key Success Factor

Education was a key factor for success, with most companies capitalizing on company-wide education programs, "green ambassadors" or education centers to instruct employees about energy efficiency. During site visits, Asia Business Council researchers noted company commitments to energy conservation in the form of colorful posters and signs above light switches reminding employees to turn off lights when not in use or where to set air conditioning controls. Many companies hold employee contests and reward and recognition programs; these activities not only broaden understanding but also serve to motivate staff members. Some companies even extend their reach into the wider community. At Esquel Textiles in southern China, for example, company managers conducted a project with local kindergartens to make the children (and their parents) aware of the importance of energy efficiency.

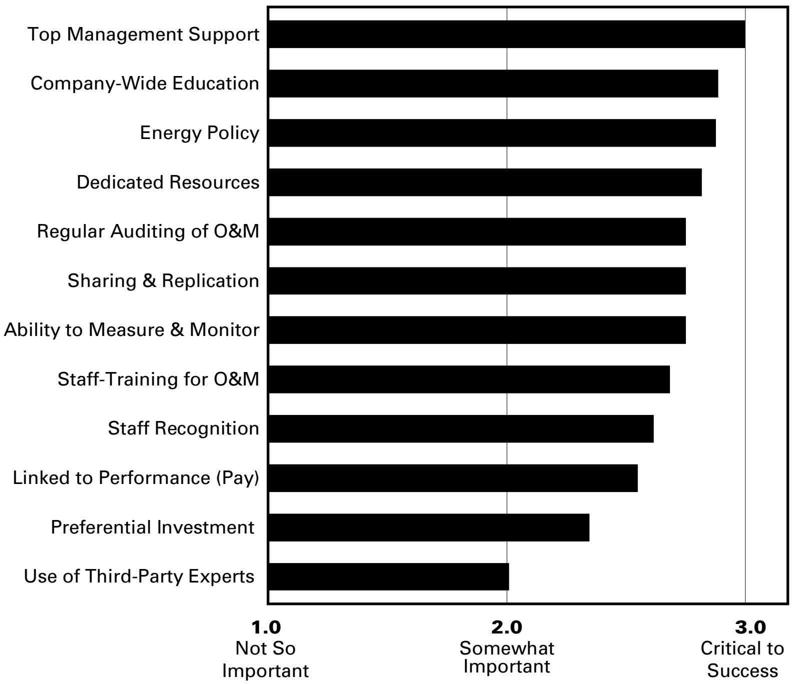
These programs often begin as cost-cutting efforts, but subsequently can evolve to support broader environmental or community responsibility objectives. Many of the energy managers interviewed commented that staff were committed to energy efficiency in the workplace because of their own desire to see a better environment.

A Dedicated Energy Manager with Multidisciplinary Team Support

Companies with energy management programs typically have a dedicated manager with some form of team support. On average, the energy manager spends 50 percent of his or her time on the job, but many have full-time staff. The energy manager often has a broad scope of responsibility and must have knowledge of technology and operations, with the ability to interact equally well with staff and senior management. Quite often, the energy manager's role is integrated into front-line management responsibility, with the energy manager providing leadership and coordination. At Esquel Textiles, for example, each business unit head has responsibility for managing energy consumption. The energy manager helps the business managers in developing measurement tools, presiding over monthly meetings to discuss and exchange tactics and assist in the identification and evaluation of energy-saving projects.

The survey also showed that energy management teams are typically multidisciplinary. Robinsons Land, a leading real estate company in the

Figure 8: Factors Critical to Successful Energy Management in Asia



Note: *O&M means operation and management

Source: Asia Business Council survey.

Philippines involved in the development and operation of shopping malls and hotels, learned of the need for multidisciplinary teams through experience: its original energy management team only included engineers and was not particularly effective. So top management expanded the team to include mall managers, mall engineers and the vice president of mall administration. This broader mix of talent enabled the energy management team to be more effective in generating and securing buy-in for new ideas and to assure that energy efficiency was not achieved as the expense of customer comfort. This team went on to meet or exceed its 10 percent energy reduction target for two years in a row.

Maintenance a Key Theme

Survey respondents pointed to maintenance as a key theme, requiring the training of staff and regular assessment of processes and procedures. H. N. Daruwalla, Vice President of the Electrical and Electronic Division of Godrej & Boyce in India, says "Maintenance is very important; otherwise you don't get the benefit of your investment in efficiency." Godrej keeps records of maintenance and briefs staff on new technologies and how to maintain them. Geronimo Magsombol, Assistant Vice President of Plant Engineering Division at electronics manufacturer IMI in the Philippines, concurred, noting that establishing good maintenance offers good gains once the systems have been optimized. Both of these companies have achieved double-digit energy savings through energy management.

Measurement Key to Energy Improvements

Survey respondents noted the importance of being able to measure energy consumption, and monitor the impact of improvement efforts, in any successful energy management program. The initial step for most companies is to determine what to measure and then to establish a benchmark as a foundation. According to Robert Allender, Managing Director of Energy Resources Management, a Hong

Kong based energy management consultant company, companies need a robust monitoring and measurement system. "In other businesses, they wouldn't invest and then not measure the results, but this often happens with efficiency investments. Few people ever look to see what happened." At Godrej & Boyce, management invested in monitoring equipment for its larger investments in energy efficiency because, said H. N. Daruwalla, "if we can't measure and monitor we can't tell if the investment is worthwhile."

At Robinsons Land, energy managers initiated their energy management strategy by developing an energy consumption baseline from five years of utility bills for each of their properties. Each month the engineers reported the reading versus the baseline data to estimate savings resulting from energy management projects. After this initial step, they listed all the consuming equipment (by name plates) and compared the actual readings to the expected performance and then selected the high-consuming equipment as a starting point for consideration of energy-saving measures.

Saving Targets Necessary

Nearly all of the energy managers reported that their programs have savings targets and many managers are held accountable for reaching these targets. Achievement influences bonuses. At ANZ Bank, for example, operational managers have hard targets, but targets for the rest of its businesses are more qualitative. The bank has sought to lower electricity consumption by 5 percent over 2 years, a practical goal. While management may have hard targets, it was also seen as important to communicate the company's achievements to all staff to reinforce the concept of cumulative accountability and to share in performance success.

Energy-Efficiency Consultants Can be Useful

The use of third-party vendors was not seen as vital to success, but survey respondents acknowledged that the use of energy-efficiency consultants can be useful when jump-starting a new program—such as establishing a measurement system or identifying key conservation projects—or as a check-up for operation and maintenance.

A Process, not a Project

When asked about "lessons learned," the respondents' most common response was the need to see energy management as a process rather than a project. Peter Shaw, senior manager of corporate real estate operations at HSBC, put it succinctly: "Energy management is a marathon, not a sprint. You set the strategy and then you keep working at it year after year."

Financial Merits of Energy Management

Interestingly, energy managers surveyed placed relatively less emphasis on preferential treatment for investment in energy-efficiency improvement projects as a key to ensuring success. Most energy managers believed that the financial merits of these investments were compelling if the proper assessment mechanisms were in place, with payback period being the most common financial measure. Most companies have differing investment approval processes depending upon the size of the proposed investment. For example, energy management team leaders usually could approve efficiency investments with a payback of less than one or two years. Proposed investment projects with longer payback periods typically required more detailed cost analysis and would require consideration by the company CFO or the energy management governing body.

Energy managers reaffirmed that when done well, energy management can be an effective tool for enhancing a company's competitiveness, cost structure and environmental footprint. As H.N. Daruwalla at Godrej & Boyce said, "If you focus on lowering materials cost you can have quality issues, and if you try to lower labor costs you can have HR issues. But when you lower your energy costs, no one is hurt. It's a win-win situation for all stakeholders."

Energy Management for Operators: A Low- or No-Cost Opportunity

> *"Energy costs are not invariable overheads; with energy audits typically demonstrating 10-25 percent energy savings achievable by business, improving energy efficiency is often one of the best ways to reduce costs, increase profits and improve competitiveness."*
>
> — Peter Young, Property Center Manager, Hong Kong Land (Property Management) Ltd.[37]

Whether the owner or a contracted management firm, the building operator is a key stakeholder in the energy performance of a building. In a modern commercial building, the operator is ultimately responsible for central air conditioning, common area lighting, elevators and other equipment, including pumps and ventilating fans. Taken together, these systems account for up to two-thirds of a commercial building's total energy usage and approximately 30 percent of operating costs.

Asia Business Council interviews show that there are many low- or no-cost opportunities to save energy in buildings that are missed because of low levels of energy-efficiency awareness among building operators. Research in the U.S. to identify frequent problems with building services (i.e. HVAC, lighting, water, heating, etc.) and estimate their impact on energy consumption identified three faults that are responsible for the most wastage: duct leakage, HVAC and lights left on in unoccupied spaces account for about two-thirds of the total energy impact of all identified problems.[38] With leaky ducts, for example, additional energy is needed as the HVAC system increases fan speed to compensate for duct leakage. A 15 percent duct leakage leads to an increase in system fan power of between 25 and 35 percent. And with fan power representing 30 to 50 percent of HVAC energy use in a large commercial building, the costs can as high as 17.5 percent of the HVAC energy consumption.[39]

A recent survey by the National University of Singapore supports these findings and shows that the energy bills for many Singaporean office buildings could be reduced by at least 10 percent through such straightforward measures as insulating air-conditioning ducts and making sure areas were not over-cooled.[40] Jon Seller, general manager of Optegy Energy Services, an energy service company in Hong Kong, explains, "You can see and hear energy inefficiency. If you walk through the building at night and hear air blowing in unoccupied spaces or you see people wearing sweaters inside on a warm day, those are signs of energy inefficiency."

Energy management is not yet widely practiced among operators in Asia. For the owner/operator, the cost of energy consumption may not be sufficient, relative to other operating costs, to warrant specific attention. Until recently, many building operators have not been concerned about energy-efficiency measures because, in the case of leased property, most pass on energy costs directly to the tenant in the form of management fees.

Despite the pass-through of energy expenses, several of the Asia Business Council's survey interviewees pointed out the economic advantage to lowering operating costs through energy efficiency. Peter Young of Hong Kong Land explains it this way: "Reduced expenses contribute to improved property yield for income property. Tenants look at rent and management fees as a total cost (gross occupancy costs). Energy is one of the property manager's largest costs; if they can be more efficient, then they can lower the management fee and up the rent, which improves net return."

Meanwhile, operating companies with more competitive cost structures will have an increasing advantage. In the 2005-2006 Annual Business Survey conducted by *Building Services Professional*, a magazine for property and facilities mangers in China and Hong Kong, 56 percent of respondents identified energy efficiency as either a new demand or one with increasing pressure from clients.[41]

Making Tenants Energy-Conscious

> *"If you have 100,000 employees and they are all doing their part, that's a big impact."*
>
> — Andrew Thomson, CEO, Business Environment Council, Hong Kong

For most of the companies surveyed in the Asia Business Council's energy management survey, energy use represented over ten percent of operating costs, but for many companies the cost of energy is not a key management concern either because costs at that level are still a small portion of operating costs or because they do not have control over energy consumption levels. For commercial tenants, energy charges for air conditioning and other common services are passed on in management fees in most cases. Energy conservation goes largely unrewarded because charges are assessed based on space, not usage.

Despite these challenges, energy-conscious procurement and management-directed efforts to improve staff awareness of energy conservation can have a big impact on expenses paid directly by the occupant. Lighting, for instance, is an area where building occupants can make improvements and harvest savings.

Lighting is one of the major sources of building energy usage, accounting for 19 percent of global electricity consumption in 2005. The CO_2 produced by generating all of this electricity amounts to 70 percent of global emissions from passenger vehicles, according to a study of the International Energy Agency (IEA). Today, half of the world's buildings are still using incandescent light bulbs, which were invented more than a century ago. These bulbs are very inefficient, converting only about five percent of the energy they receive into light. Fluorescent tube lights, the dominant lighting systems in commercial and public sector buildings, vary widely in efficiency—between about 15 to 60 percent. And halogen lights, popular in middle-class homes and in commercial buildings, are the least efficient of all commonly used electric lighting systems, adding a large amount of heat into the living space as a by-product and requiring additional air-conditioning energy for its removal. The IEA notes a global switch to efficient lighting systems, which are readily available today in the market, would trim the world's electricity bill by nearly 10 percent, with reduced CO_2 emissions higher than cuts achieved so far by adopting wind and solar power (see Box 8).[42]

In Asia, lighting's share in national electricity consumption is even bigger than the world's average, reaching around a quarter of the total. Building occupants' choice of lighting systems may have a huge impact on national energy consumption. In China, for instance, if highly-efficient fluorescent tubes and ballasts, the devices that regulate input voltages for the lamps, were installed in all buildings, the savings would offset the need for a new Three Gorges Dam project every eight years.[43] For companies, choosing high-efficiency lighting systems translates into financial paybacks. For example, Compact Fluorescent Lamps (CFLs)

Box 8: Inefficient Lighting Systems & Today's Alternatives

With the development in lighting technology in the past 10 years, new energy-efficient lighting systems can help cut lighting energy consumption up to 80 percent while enhancing lighting quality and reducing environmental impact.

Inefficient lighting systems:

- Incandescent bulbs
- Low-efficiency fluorescent tubes
- High-loss ballasts for fluorescent tubes
- Conventional halogen lights
- High-loss halogen transformers
- Mercury discharge lamps (often used in street lighting)
- Low-efficiency vehicle lighting
- Fuel-based lighting in developing countries

Today's alternatives:

- Compact Fluorescent Lamp (CFL): CFLs were first introduced to the market in 1980, but there have been major improvements in their size, weight, and light quality during the past few years. Compared with incandescent bulbs, CFLs can save up to 80 percent of electricity and last up to 12 times longer (from 3-12 years).
- High-efficiency Halogen: Halogen lights deliver brilliant light quality, with the best color rendition. High-efficiency halogens can achieve 20 to 30 percent energy savings compared with conventional ones.
- Light Emitting Diodes (LED): LEDs are highly efficient, and are mainly used for decorative replacement.

Sources: International Energy Agency (IEA), see: http://www.iea.org/

can save up to 80 percent of electricity and last up to 12 times longer compared with incandescent bulbs.

Besides lighting, computers, room air conditioners and many equipment and appliances are also available in high-efficiency models (see Box 9). Establishing energy-conscious procurement criteria that make reference to local or international energy-efficient labeled products is an important initiative for both company tenants and individuals to improve energy efficiency.

Occupants' energy-saving activities, such as turning off lights and air conditioning when they are not in use, making good use of daylighting and natural ventilation, and avoiding over-lighting and over-cooling/heating can also have a significant impact. For energy management programs initiated by company tenants, staff awareness is the key. Raising staff awareness begins with good company policy. After that, success comes with good communications. A common theme among the respondents of the Council's energy management survey is that, for staff with little direct control over energy consuming equipment, the positioning of energy efficiency must be related to outcomes they can control. For example, when the link is made between energy conservation and their everyday life, staff feel a closer connection to the objectives and motivation increases. At Jones Lang LaSalle, there is a note in each conference room reminding staff to turn off the lights. It says "Lighting an empty office overnight wastes enough energy to heat water for 5,000 cups of coffee."

Companies across diverse industries are beginning to see the benefits of a well-orchestrated energy management program

Box 9: Procurement and Energy Savings

Typical savings potential for the most common types of devices in use today, compared to the most efficient technology available:

- Appliances: 45-55 percent
- Air conditioning 40-50 percent
- Lighting: 70-80 percent
- Stand-by power: 72-82 percent

Source: World Business Council for Sustainable Development, 2005, "Pathway to 2050: Energy and Climate Change," see: http://www.wbcsd.org/

in terms of operating cost savings, reputation enhancement and staff motivation. Energy cost savings of five to 25 percent with little capital investment were a common range for commercial tenants reported in Asia Business Council's interviews.

The Upgrade Opportunity for Owners

> *"You can realize significant energy savings through good lighting and HVAC choices and operational changes in all buildings. 20 percent is typical and 50 percent is not impossible."*
>
> — Andrew Thomson, CEO, Business Environment Council, Hong Kong

The efficiency of a building erodes over time as systems wear out and ultimately need to be replaced. Making the case for major systems retrofits based on energy efficiency alone can be difficult, but there is a substantial opportunity to upgrade energy performance as part of the normal building renovation process with HVAC systems, lighting and window treatments and coverings being the most common target areas. The upgrade process is a window of opportunity to improve both building energy performance and comfort levels (see Box 10).

There are many ways to incorporate energy efficiency in building renovation projects. Some of the simplest ways to add energy efficiency to retrofit projects include using efficient lighting, appliances, and equipment. Improved controls can also reduce HVAC and electrical use. Generally, those energy-efficiency principles for new building design also are applicable to the renovation of existing buildings. These include considering systems interactions, using life-cycle costing to evaluate high-efficiency choices and ensuring a thorough commissioning process that includes training and documentation.

Around Asia, there have been numerous examples of companies saving money through retrofitting existing properties. For example, the Mike Shopping Mall in Thailand achieved energy savings of 31 percent and investments were paid back in 1.3 years after retrofitting. The retrofit of the Sultanah Zanariah Library of the Universiti Teknologi Malaysia (UTM) enabled a reduction of 36.5 percent of the original energy consumption and greatly improved the indoor comfort of the library. In Singapore, the Shangri-La Hotel saved SGD$900,000 (around US$600,000) every year and achieved increased energy efficiency of 43 percent after retrofitting. In Hong Kong, an energy-efficiency retrofit of office building Cityplaza (III& IV) achieved annual savings in electricity cost of around HK$1 million and the payback period is approximately three years (see Part II for cases).

Recommendations for Greater Energy Efficiency

Asia Business Council interviews with developers and designers familiar with energy-efficiency concepts confirm that the responsibility for assuring the achievement of energy efficiency lies initially with project developers in how they define the project objectives, select the design team and control the building budget. But their role is just a first step in the life-cycle of a building. Later in the life of a building, those who occupy and run the property have an increasingly important role as good stewards of energy efficiency.

Based on Council interviews with practitioners and its energy management survey on factors critical to successful energy management, the following are recommendations for improving the energy efficiency of Asia's buildings.

Box 10: Window Treatments and Coverings

Some carefully selected window treatments can reduce heat loss in the winter and heat gain in the summer, including:

- Awnings
- Blinds
- Draperies
- High-reflectivity films
- Insulated panels
- Mesh window screens
- Overhangs
- Shades
- Shutters
- Storm panels

Window treatments, however, aren't effective at reducing air leakage or infiltration. Caulking and weatherstrip around windows are needed to reduce air leakage.

Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy program, see: http://www.eere.energy.gov

Build or Buy Expertise

Developers keen to incorporate energy efficiencies in their projects need to begin by building up their internal understanding of energy-efficient design concepts. Evaluation of demonstration buildings, and participation in certification schemes or one of the many green building ratings systems, are ways to raise awareness of energy-efficient design concepts and strategies.

The same is true for building operators. One way that operators can achieve greater savings in maintenance costs is to train their own teams. Many of the firms practicing energy management had training budgets both for their operations and management staff to introduce them to energy management skills and provide advanced technical courses to keep up with rapidly changing technology. At Hysan Development, management offers hands-on, in-house training and pays for its employees to participate in courses that bring them up-to-date on the latest technologies. Buying technical maintenance expertise from outside contractors is another option, although it can be a costly one.

Establish an Energy-Efficiency Objective

Establish an energy-efficiency objective in the scope of work for new building design, existing building retrofit, and building operations. Where available, use building energy consumption benchmark data as a reference or target achievement of voluntary energy performance rating levels and mandate that energy-efficiency options be evaluated with consideration of their lifecycle costs. Assure that the project team understands the efficiency objective and the objective is supported throughout the life-cycle of the project.

Pursue Integrated Design

To make the transition from sequential to more integrated design, firms can make investments in staff training as well as hire or contract specific energy-efficiency expertise such as engineers with energy modeling capabilities. A project manager is a key role and should be knowledgeable about the project's energy-efficiency goals. Early involvement of the building operator also is important to the project's success. When the project sponsor is not in the building business, it should take particular care to select a design team with demonstrated experience with integrated design and energy-efficiency concepts.

Choose the Right Size for Key Building Systems

While the objective of integrated design is to optimize the interaction among building components, this level of design skill may not be practical or available in the market. But choosing the appropriate size for a building's heating and cooling systems is typically within reach. One energy consultant the Asia Business Council interviewed called the HVAC system the "low-hanging fruit," and recommended that if developers/owners do nothing else, they should challenge their engineers to design a smaller HVAC system in new building design and building retrofit.

Lighting is another system that can be improved through selection of better components and thoughtful design. For example, one simple design technique is to install lighting in rows parallel to the windows with separate controls for the rows. When natural lighting is sufficient, the lights near the windows can be turned off while darker regions remain illuminated. Good controls such as occupancy sensors that automatically turn off lights when movement is not detected can also save in common areas or during off-hours.

Choose the Right Operation Pattern for Key Building Systems

By observing how building occupants use energy, building operators can ensure that energy is not being squandered. If tenants have not been sensitized to energy conservation, they often waste a lot of energy by leaving lights and air-conditioning on. Hysan Development analyzes the usage in common areas such as elevator traffic patterns, lighting needs, and room temperatures, and re-adjusts the system to assure that only necessary systems are being used. In Hong Kong, these analyses have yielded savings of between 10 and 15 percent.

Commission the Building to Realize Energy Savings

According to leading architectural firm HOK International, a 20 percent annual energy savings can be achieved if buildings are operated as designed.[44] While full independent commissioning of buildings is not common In Asia, a number of practical changes to standard market practice can improve building operating efficiency and smooth the hand-over process. Assure objectivity on the part of the commissioning agent or consider investment in independent verification of testing and commissioning. Focus effort on buildings systems that consume the most energy and set delivery dates for operation and maintenance manuals and training to allow sufficient time for review and approval. Consider penalties for late delivery.

Box 11: Commissioning: Recommended Practices

- Designate a commissioning agent: either an independent third party or a qualified member of the team who is an objective advocate of the owner's interests.
- Include detailed commissioning requirements in the design specifications.
- Include commissioning elements in the tendering documents to ensure adequate resource allocation.
- Provide thorough documentation of system design intent and operating sequences.
- Verify system performance based on documented functional testing and measurement.
- Prepare O&M manuals and provide training of building operations staff on system operations and maintenance procedures.

Make Efficiency Part of the Building Operations Strategy

Because successful energy management programs start from the top, the property owner must establish energy management as part of the building management strategy and institutionalize energy efficiency in performance measures across the operator's range of activities. Key steps include establishing an energy management policy, appointing an energy manager and supporting energy-efficiency-oriented resource allocation.

Property owners who use an outside building management company should consider the provider's track record in energy efficiency, increasingly a point of differentiation amongst top property or facilities management firms, as part of the evaluation process. For example, at HSBC in Hong Kong, the company made the strategic decision to outsource all of its facilities management and included energy management in the scope of the contract. The outsourcing contract specifies a number of energy management responsibilities and includes an incentive to manage the budget and share a percentage of the savings achieved.

Establish Energy Measurement and Monitoring Tracking

Measurement and monitoring of energy consumption is very important to the success of an energy management program. Based on his experience in energy-saving projects, Cary W.H. Chan, Head of Technical Services of Swire Properties Management Ltd. in Hong Kong, suggested that operators collect and assess operation data of a building's mechanical systems continuously to determine the relationship between the efficiency of mechanical systems and various changing factors. The change of the control strategy of the air conditioning system in Festival Walk was done after a year of monitoring operating data, which allowed the operators to identify the deficiencies in its previous management system. Through continuous capture and analysis of energy consumption data of its buildings, Swire has constructed a knowledge base for exploring new improvement opportunities.

Peter Young of Hong Kong Land advises energy managers to agree to a standard of measurement with allowances for seasonal variation to assure that the information is useful to end-users and helps them make decisions. Energy consumption reporting should be shared widely and should be a component of mainstream financial accounting in order to raise the profile of energy management.

Incorporate Life-Cycle Cost Analysis in Budgeting and Procurement

An investment in energy-saving projects may not pay off in the short run and may not be justified if decisions are made based only on initial costs and short-term payback. Life-cycle cost means the total cost of owning, operating and maintaining a building over its useful life.[45] The core concept of life-cycle cost analysis is that both costs and benefits must be considered over the entire project life cycle and that design decisions are not based only on initial costs.

For larger capital investment items in both new building design and existing building retrofits, the use of life-cycle cost analysis must be part of the project mandate and specified in tender documents to help developers and owners make sound decisions. Companies can specify life-cycle parameters for major equipment as part of their tender requirements, so that vendors provide comparable information for their analysis.

Life-cycle cost thinking should also be applied in building operations. Most of the building operators the Asia Business Council spoke with work with three- and five-year

Box 12: Life-Cycle Cost Analysis in Typical Cases

There are two major cost categories under which projects are evaluated in a life-cycle cost analysis:

- Initial Expenses (one-time start-up costs): all costs incurred prior to occupation of the facility, including construction management, land acquisition, site investigation, design services, construction, equipment, technology, indirect/administration, art, and contingency.
- Future Expenses: all costs incurred after occupation of the facility, including (1) operation cost (annual costs) which consists of fuel, electricity, water and sewer, garbage disposal, custodial, grounds, lease, and insurance; and (2) maintenance and repair cost (scheduled and unscheduled upkeep costs) including site improvements, site utilities, foundation/substructure, superstructure, exterior wall systems, exterior windows, exterior doors, roof systems, interior partitions, interior doors, interior floor finishes, interior wall finishes, and interior ceiling finishes.

Source: The U.S. Department of Education & Early Development, 1999, Life Cycle Cost Analysis Handbook, State of Alaska, 1st Edition.

budgets and energy-saving targets. But the annual budgeting practice common for many firms is often a barrier to improved efficiency. An annual budget, typically based on the previous year's expenses, makes it difficult for operations and management managers to get approval for energy-efficiency investments.

Much like designers, building managers and owners need to consider life-cycle cost in their decision-making about procurement of equipment and services or regarding construction or improvements to a facility. Better procurement and investment decisions can be made when future energy savings and maintenance costs are taken into account. In Hong Kong, HSBC replaced the chillers for the air-conditioning system in the HSBC main building in 2003 with more expensive but energy-efficient ones. Although the new chiller saves about HK$1 million (around US$128,000) in energy cost every year, from the first cost and payback calculation at least five years would be needed to reap any return. Calculating the return against the costs during the entire lifecycle of the system however, the project may give HSBC a HK$16 million (more than US$2 million) return.[46] For companies that have to justify the business case for every energy-saving project based on a payback period of two or three years, such a considerable return would be missed.

Building a Better Policy Framework

The Market Inefficiencies Hindering Energy Efficiency

> *"I believe in the market. Vendors are always trying to sell us equipment with fantastic efficiency claims. If the business case for energy efficiency is so strong, I'd expect to see more energy-efficient buildings."*
>
> — An Asian real estate developer.

There is a widespread belief that energy efficiency is not economically compelling, and that the current paucity of energy-efficient buildings proves this. This misconception reflects a lack of understanding about the true costs of high energy use—and the fact that many of those involved do not pay the costs. In some cases, electricity is directly subsidized, which encourages waste. In no case are all the so-called externalities—notably environmental damage—priced into electricity bills.

Many technological and other solutions exist to improve building energy efficiency. A growing number of state-of-the-art building projects around the world demonstrate the technological and financial rationale for adopting better energy-efficiency designs and systems. The example of California, which has witnessed significant savings through managing the demand for electricity (of which increased building efficiency is a major component) shows that strong government policies can work hand-in-hand with market forces. However, the take-up of energy-efficiency measures in Asia has been slow, illustrating that sometimes the market alone may not be enough to spur a new generation of energy-smart decision-making.

On the demand side, energy efficiency is not a significant criterion for most people selecting a residence or office space. In many cases, energy costs constitute only a small proportion of the operating cost or household expenditure, and building consumers tend to focus on main cost factors affecting their bottom line. Every bit as important, even those consumers who do care often do not have access to sufficient information to be able to compare "green" offerings or to evaluate claims of improved energy efficiency in financial terms.

For commercial tenants, as mentioned before, most energy charges (e.g. the energy charge for central air-conditioning) are generally passed on as management fees. Energy charges are not typically broken out for comparison nor can the charges be reduced through tenant conservation efforts because they are assessed based on the amount of space, rather than energy usage. This lack of price incentive is a significant hurdle to any emerging demand for greater energy efficiency.

On the supply side, an energy-efficient building may cost more than a traditional building, and may not be viable for those developers that make investment decisions based on first-cost evaluation. Meanwhile, the relative lack of credible building energy performance rating and certification systems means that investments in energy efficiency are largely invisible. Thus, a lack of market appreciation means any investment in energy efficiency is difficult to value and recoup in the marketplace.

Similarly, landlords of existing properties lack incentives to upgrade efficiency simply because they do not pay the energy bills. For those who build, own, operate, and occupy their own buildings, energy efficiency appears to be an attractive idea since they would benefit from their own investment. However, owners often do not want to make investments with a payback longer than a few years.

Fragmentation within the building industry complicates the process of improving energy performance. No single company or professional association handles the full range of processes and functions involved, including designing, constructing, engineering, property managing, etc. Many players in the sector make it difficult to mount a coordinated energy-efficiency effort.

These market inefficiencies are further complicated by market-distorting government policies, including subsidies for oil and other sources of energy. Energy pricing is crucial for the implementation of overall energy-efficiency measures. Market-based pricing encourages the efficient use of energy as it punishes unsustainable consumption and rewards wise measures. Subsidies reduce incentives to use energy rationally. However, energy prices are so entwined with a nation's economy that the government is usually under political pressure to provide subsidies to keep energy prices low. According to McKinsey, at least 20 percent of current global energy consumption is subsidized or mispriced in a significant way.[47] In Asia, the prevalence of various forms of energy subsidies has acted to prevent the region from becoming more efficient in energy consumption.

Notwithstanding this overall picture, Asia Business Council interviews revealed that property managers and analysts see an emerging demand for energy-efficient and green buildings from environment-conscious multinational corporations; how extensive a demand is still difficult to quantify. According to Peter Young of Hong Kong Land, sustainability is a factor expected to materialize in the future based on global trends. "Energy efficiency [in the local market] is not tenant-driven yet, but in five to six years it will figure more prominently in demand."

For much of Asia, building energy efficiency is a new concept and activity is limited to public buildings and a small number of leading businesses. These companies are pursuing building energy performance gains to demonstrate their corporate commitment to their communities and the environment, attract the highest-paying tenants, or provide a healthier indoor environment for their staff. The greatest challenge to improved building energy efficiency tends to be human rather than technical factors; in the absence of well-designed public policy measures to stimulate the supply and demand sides of the equation, improvements in building energy efficiency will continue only at a slow pace.

Policy Tools for Market Transformation

Because the market in Asia for energy-efficient buildings is still nascent, there is significant opportunity for forward-looking governments to join with key business leaders in stimulating a market transformation that shifts both supply and demand and improves the availability and affordability of energy-efficient buildings.

Development and implementation of a regulatory "push," which establishes and enforces legal minimums, and a complementary "pull" from market-based, non-regulatory mechanisms, which increases awareness and stimulates investment in performance beyond legal requirements, would create an efficient policy mix that accelerates the move towards energy efficiency. Basic tools of such a policy mix might include appliance/equipment labeling and standards, building energy standards, building energy performance rating and labeling, financial incentives, industry capacity-building, government modeling, and demonstration projects. These tools are analyzed below.

Appliance Standards and Labeling

The two most widely-utilized and thoroughly-studied programs internationally are the minimum energy performance standards (MEPS) and energy performance labeling for appliances and equipment. These two programs are complementary: whereas MEPS establish a regulatory minimum energy performance requirement, eliminating inefficient models and forcing consumers to purchase a minimal level of energy-efficient products, labeling offers product differentiation and allows consumers to make informed choices. Together, these mechanisms shift the distribution of energy-efficient models of products sold in the market upward, and form the foundation for most energy-efficiency policies worldwide and drive the energy efficiency of most of the appliances and equipment that consumers plug in.

The effectiveness of mandatory MEPS and labeling program in energy savings has been widely proved. For example, South Korea has reduced the energy use of refrigerators by 74 percent in 10 years;[48] Thailand has increased its share of high-efficiency refrigerators from 12 percent in 1995 to 96 percent in 1998.[49] In the U.S., the average new refrigerator sold today uses, per year, only a quarter of the electricity that would have been used by a refrigerator sold 30 years ago when standards and labels were first introduced, despite the new product's increased size and added features.[50]

Asia Business Council interviews and a review of the literature show that voluntary MEPS and labeling programs may be effective but are limited in some cases.[51] Only with mandatory MEPS can inefficient products be removed from the market, and only with all products labeled do consumers have adequate information. However, for economies that are new to standard-setting and labeling and/or have limited resources to apply to standards, a voluntary labeling program may be the place to start.

MEPS should be established based on the technical capability of local suppliers, as well as the average efficiency of imported products. As product energy efficiency improves, the standards and labels need to be regularly revised and upgraded to ensure continuous improvement and drive product innovation and, in some cases, enhance export competitiveness.[52] If the domestic standards are too low, the country risks becoming a dumping ground for low-efficiency imported products.

In Asia, MEPS and labeling of appliances have been widely adopted in the 11 economies studied (see Table 5).

- 10 of the 11 economies adopted MEPS for certain types of appliances, among which nine (China, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan and Thailand) have mandatory MEPS. Hong Kong is the only economy that doesn't have a standard program for appliances, while Singapore has standards for only one type of appliance.

- All 11 economies have implemented labeling programs, and four of them (China, the Philippines, South Korea and Thailand) have mandatory labeling for certain types of appliances/equipment.
- In terms of the coverage of MEPS and labeling, China has the program that covers the most types of products (followed by Japan, South Korea, and Taiwan). However, China's standards for room air conditioners are nearly 50 percent looser than their Japanese counterparts.[53]
- Japan has adopted an unique approach in setting energy conservation standards for appliances (see Box 13).
- Most Asian economies are now upgrading and expanding their programs, setting higher standards for more types of appliances and equipment.

Building Energy Standards Level the Playing Field

Building energy standards (or codes) are the foundation for building energy policies.[54] They can be especially important when consumers are prone to focus on aspects other than energy use when buying or renting new homes or offices. Standards provide a minimum level of energy performance to ensure that all buildings meet a reasonable level of energy efficiency. Introduced since the oil crises of the 1970s, building energy standards are widely proven to spur greater energy-efficiency improvement. For example, four generations of building energy standards and standards in the U.S. have produced estimated energy-efficiency improvements of about 60 percent over a 30-year time frame.[55]

As energy-efficiency opportunities are more widespread and cost-effective in the design stage, most building energy standards are targeted at new buildings, as well as major renovations or systems replacement in existing buildings. The standards usually are directed at the insulation of the building envelope; air filtration, lighting and mechanical equipment may also be included.

The combination of building energy standards and appliance/equipment standards and labeling has proven cost-effective. For example, California's energy-efficiency programs over the past 30 years have enabled California to hold per capita electricity use essentially constant, while the rest of the nation saw per capita electricity use increase by nearly 50 percent. Of the savings, more than half are attributed to the implementation of building and appliance efficiency standards. Its latest building and appliance standards, adopted in 2004, are expected to avoid the need for five giant power plants in the next 10 years.[56] Estimates suggest that in a sample of developing countries, 11 to 16 percent of all energy consumed could be saved between 2000 and 2020 through appliance/equipment standards and labeling and building energy standards.[57]

All of the Asian economies covered in this report have some form of energy building standards. Japan and Singapore were the first two countries in the region to develop and implement building energy standards in the 1970s after the oil crises (both in 1979), followed by China (1986), Malaysia (1986 and 1987), Indonesia (1988 and 1989), and the Philippines (1988 and 1989) in the 1980s; Hong Kong (1995), Taiwan (1995 and 1997) and Thailand (1995) in the 1990s, and, more recently, India (2001) and South Korea (2004). Energy standards in most economies currently focus on new buildings (the design stage of building) and renovations or replacement of major systems in existing buildings. However, more and more Asian economies are trying to establish standards that cover other stages of the building life cycle.

There have been divided opinions about the stringency level of building energy-efficiency standards in Asian countries compared with those in developed regions. The McKinsey Global Institute's study on global energy demand growth in May 2007 noted that building energy-efficiency standards in China are significantly below global benchmarks. For instance, standards in China allow double the leakage of developed-country standards in similar climates.[58] However, Joe Huang, scientist at Lawrence Berkeley National Laboratory in the U.S., told Asia Business Council researchers that his study on standards in both China and the U.S. for similar climate conditions showed that the Chinese standards are more stringent in some areas while the U.S. standards are more stringent in others—they are different. He thinks that there are no such things as global benchmarks, and the current Chinese standards are appropriate to China considering the technological and economic context.[59]

More important, there are differences in comprehensiveness, enforcement, and compliance of building energy standards within Asia. Asia Business Council's research and interviews suggest that Japan, Singapore, South Korea and Taiwan have the most established standards, supported by established compliance mechanisms and enforcement systems and systematic revisions.

A review of the literature shows divided opinions on whether mandatory building energy-efficiency standards or voluntary ones are more effective. Advocates of mandatory standards believe

Box 13: Japan: The Top Runner Program

Since 1999, Japan has been implementing the Top Runner Program to set energy conservation standards for home and office appliances and cars. In many countries, the energy efficiency of electrical appliances is enhanced by MEPS. Japan followed a different strategy. Instead of setting a MEPS, its Top Runner Program searches for the most efficient model on the market and then stipulates that the efficiency of this top runner model should become the standard within a certain number of years. By the target year, each manufacturer must ensure that the weighted average of the efficiency of all its products in that particular category is at least equal to that of the top runner model. This approach eliminates the need to ban specific inefficient models from the market. At the same time, manufacturers are made accountable and, perhaps most importunately, they are stimulated to voluntarily develop products with an even higher efficiency than the top runner model.

Source: Energy Conservation Center, Japan (ECCJ), see: http://www.eccj.or.jp/index_e.html that a mandatory approach helps level the playing field for developers and builders, as energy-conscious designers and building professionals do not have to compete with others who achieve construction cost savings by eliminating or ignoring energy-efficient features.[60] Detractors argue that setting appropriate standards is difficult, since what may be desirable in one building may be undesirable in another. Mandatory standards also may limit design freedom and innovation if the standards are not sufficiently comprehensive or flexible.

No concrete empirical evidence supports the mandatory approach. For example, surveys conducted by the U.S. Department of Energy indicate that mandatory energy standards often are ignored because they are too complex and difficult to understand.[61] A World Energy Council study concluded that "there is no hard and fast rule about which one is more effective since the success of BES (Building Energy Standards) depends not only on how it is designed and coded but also how it is implemented and publicized."[62]

Table 3: Market Inefficiencies Limit Supply and Demand

SUPPLY	DEMAND
First-cost focus – limited understanding of life-cycle costs	Energy performance not buying criterion
Pass-through of energy costs to tenants/residents	Energy cost only a small part of total operating cost
Limited awareness of link between energy consumption and environment	Lack of control over allocated energy consumption charges
Low industry awareness of energy-efficiency concepts	Limited awareness of link between energy consumption and environment
Lack of credible building energy performance rating systems that differentiate between products	Lack of information about relative energy performance
Lack of high-performance building materials and equipment	Insufficient information to be able to establish financial value of energy performance
	Lack transparency of building energy charges

However, researchers in Asia who the Asia Business Council interviewed tend to support a mandatory approach.[63] A review of building energy standards in the 11 Asian economies studied also shows that governments in Asia tend to favor mandatory standards to voluntary ones; seven (China, Hong Kong, the Philippines, Singapore, South Korea, Taiwan and Thailand) of the 11 economies have mandatory building energy-efficiency standards, with Japan planning to make its standard mandatory in 2007 and India planning to formally adopt a mandatory standard in the coming years.

There is also a general trend of upgrading and strengthening building energy standards among these economies, indicating that Asia is imposing more stringent requirements on the energy performance of buildings.

Building Energy Performance Labeling Stimulates Efforts Beyond the Minimum

Although mandatory building standards establish minimum thresholds and remove the worst performers from the market, they generally do not stimulate innovation. Rating[64] and labeling building energy performance is an effective measure to encourage developers and owners of new and existing buildings to go beyond the minimum. Of course, uptake depends on informed consumers seeking more environmentally friendly buildings, with energy labeling serving to differentiate market offerings.

The voluntary rating and labeling of buildings in terms of energy performance has been adopted in Japan, Singapore, South Korea and Hong Kong (see Box 14). Beyond the energy performance labeling program, green building rating and certification systems aimed at rating and certifying the comprehensive environmental performance of buildings are winning broader international acceptance. In Asia, green building programs have achieved substantial gains in the past five years in Hong Kong, Japan, Singapore, Taiwan, India, and South Korea. In China, the government unveiled a green building rating system in 2006 (see Boxes 15 & 16). This trend implies that the energy/environmental dimension of buildings is gradually becoming visible to consumers, which could in turn influence developers' reputations and marketing strategies, as well as consumers' purchasing decisions.

While industry-initiated efforts are playing a significant role in promoting the concept of green building in Western countries, Asia is relatively weak in this regard.

Voluntary green building rating and certification programs developed by the private sector are the exception, not the rule, in Hong Kong and India (please see Box 17). Hong Kong is the first economy in Asia to establish its green building rating system, the Building Environmental Assessment Method, or BEAM, which was developed by an industry association. BEAM is also the most widely used green building rating system on a per capita basis in Asia. In India, the Green Rating for Integrated Habitat Assessment, or GRIHA, was developed by the private sector. Since being established, these two schemes have generated considerable interest in built-environment sustainability in the building industry in their respective territories.

In most Asian economies, however, including China, India, Indonesia, Malaysia, the Philippines, and Thailand, the concept of green building is still in its infancy. While there are a few projects intended to improve environmental performance including energy efficiency, no concerted move towards green and sustainable design and the use of green building products yet exists.

Globally, in economies where energy performance or green building labeling exists, there is momentum for states, communities, public agencies and leading companies to incorporate labels into design mandates or tenancy criteria as a means to specify and demonstrate environmental performance. In Australia, two state governments have rewritten their accommodation policies mandating specific star ratings for all tenancies. In the U.S., a number of communities and local governments have mandated that all new construction meet "Energy Star" performance levels. The EU has taken the most dramatic step with the European

Union Energy Performance of Buildings Directive published in 2003, which requires all building construction, sales and rental transactions to be accompanied by an energy performance certificate. EU member states have until 2009 to implement the directive completely. South Korea is considering a similar plan, requiring that all real estate transactions include an energy-efficiency certificate, with the associated document attached to all sales transactions.

Policy makers are watching these trends closely and there is considerable optimism in energy-efficiency policy circles that energy rating and labeling of buildings will be the key to making investments in energy efficiency visible, thereby increasing their value. The labeling of buildings may have the desired market transformation effect because building labeling is one of the few initiatives that directly address the energy performance of existing building stock.

Financial Incentives

Standards work best in coordination with targeted financial

Box 14: Building Energy Performance Labeling Programs in Asia

Japan in 2000 adopted the Housing Quality Assurance Law, a voluntary housing performance labeling system with standardized criteria for evaluating housing performance. Building energy efficiency is rated as part of the assessment of the building's thermal environment.

Singapore's Energy Smart Building Scheme, launched in 2005, awards an "Energy Smart" badge to commercial buildings that are among the top 25 percent in energy performance. The program is planned for expansion to other building categories.

South Korea's Energy Efficient Labeling Program for Buildings targets newly built or renovated residential units for classification into grades 1 to 3, depending on the use of energy-conserving facilities and equipment. Buildings that are above a certain performance standard will receive the Certificate of Building Energy Efficiency and a lower interest rate loan for construction.

Hong Kong promotes adoption of voluntary standards through the Energy Efficiency Registration Scheme begun in 1998. Designers, developers and property management companies may submit details of their building for assessment. If the building is determined to be in compliance with the standards, a registration certificate is issued. As of December 2006, 1,722 registration certificates were issued for 713 buildings.

incentives that encourage compliance with the standard, encourage production of efficient appliances and equipment locally, and encourage efficiencies beyond the minimum standards.

Financial incentives include economic and fiscal ones. The objective of economic incentives is to stimulate energy-efficiency investments. These incentives fall into two broad categories: investment

Box 15: Government-Initiated Green Building Programs in Asia

Japan: Comprehensive Assessment System for Building Environment Efficiency (CASBEE) (effective since 2004)
CASBEE is a green building rating system developed by the Japan Sustainable Building Consortium in 2004 to assess the environmental efficiency of buildings. It is a voluntary program being implemented by local governments, with training for assessors and third party assessments. Developers, builders, architects and others can download a program that allows them to assess any new building or renovation on their own. They may also hire trained architects who have passed a CASBEE assessor exam to conduct the assessment. CASBEE has received a great deal of publicity among both government and industry, as well as in other Asian countries such as India and China. The CASBEE rating system has been adopted for Beijing's Green Olympic Building Assessment System (GOBAS).

Source: Institute for Building Environment and Energy Conservation, Japan, see: http://www.ibec.or.jp/CASBEE/english/overviewE.htm

Singapore: Green Mark Scheme (effective since 2005)
The Green Mark Scheme was launched by the Building & Construction Authority in 2005. The scheme is available for both new and existing buildings and provides three levels of financial incentives (gold, gold plus, and platinum), corresponding to increasing levels of green technologies and energy savings obtained. For energy performance, the gold level requires energy efficiency at the level required by the building standard. The gold plus level requires energy performance 25 percent better than standard, while the platinum level requires energy efficiency 30 percent better than the standard. The incentives range from SGD$3 per square meter to SGD$6 per square meter of gross floor area for new building; retrofit of existing buildings is eligible for about 40 percent of the incentive for new buildings per square meter. The government is planning to make it mandatory for all new public sector buildings and those undergoing major retrofitting works to receive Green Mark certification.

Source: Building and Construction Authority, see: http://www.bca.gov.sg/GreenMark/green_mark_buildings.html

Taiwan: Ecology, Energy, Waste and Healthy (EEWH) (effective since 1999)
In 1999, the Architecture Research Institute of the Ministry of the Interior developed the EEWH system. It is a special chapter in Taiwan's national building code. EEWH evaluates buildings based on 9 indicators including biodiversity, green landscaping, site water conservation, CO_2 emissions reduction, waste reduction,

subsidies and soft loans. Fiscal incentives aim at reducing the tax paid by consumers who invest in energy efficiency, comprising tax reduction, accelerated depreciation, tax credits and tax deductions.

Incentives are widely utilized in the U.S. (see Box 17 for incentives targeted at the building sector) and EU to promote energy efficiency in all sectors. In Asia they are aimed more at the industrial sector than

Box 15 Continued

indoor environment, water resources, sewage and garbage treatment, as well as energy conservation. It targets newly-built buildings and issues two types of certification to buildings, the "Green Building Label" and "Green Building Candidate Certification." EEWH is a voluntary program but has been mandatory for all new official buildings of the central government since 2002, and for local government buildings since 2003.

Source: Taiwan Green Building Council, see: http://www.taiwangbc.org.tw/

South Korea: Green Building Rating System (effective since 1999)
This program evaluates six elements affecting the environment throughout the life cycle of the building construction process (production of materials, design, construction, maintenance and dismantling of buildings). Under this program, certification audits will be targeted for existing buildings, but, if the construction contractor desires to be audited from the beginning stage of design, a preliminary certification will be endowed. This system has four grades and the term of validity for the certification is five years. Extension may be requested for an additional five years. After 10 years, the regulation requires renewal. This program is currently limited to multi-dwelling units, housing and commercial complexes, businesses (public, private buildings), commerce (schools, hospitals, etc), and remodeled buildings.

Source: Korea Green Building Council, see: http://www.gbc-korea.co.kr/index.asp

China: Evaluation Standard for Green Building (effective since 2006) & Green Olympic Building Evaluation Standard for Green Assessment System (yet to be formally launched)
The Evaluation Standard for Green Building is set at a similar level to the LEED standard. The Ministry of Construction collects building energy consumption data, assesses energy performance based on the standard, and issues the three-star green building certification to qualified buildings. The local government will be in charge of issuing lower level one-star and two-star certifications.

To support the idea of a Green Olympics for the 2008 Games, the Beijing Science and Technology Commission sponsored the development of another green building rating system, Green Olympic Building Assessment System (GOBAS), led by Tsinghua University. The system is modeled primarily on Japan's CASBEE and, to a lesser extent, on LEED.

Source: Joe Huang, Staff Scientist, Lawrence Berkeley National Laboratory, Berkeley.

at the building sector. In relative terms, Japan, Singapore and South Korea are using financial incentives more extensively. They are being applied on a smaller scale in Hong Kong, Malaysia, Thailand, and Taiwan. China is planning for them as well (see the country profiles in Part III for incentives).

In spite of the wide application of incentives, countries have taken diverse approaches, and a comprehensive review of experience with ap-

Box 16: Business-Initiated Green Building Programs in Hong Kong and India

Hong Kong: The Building Environmental Assessment Method (BEAM)

BEAM is a voluntary certification scheme launched in 1996 by the HK-BEAM Society, a non-profit organization consisting of developers, building professionals, contractors and property managers. BEAM recognizes improved environmental performance in building design and management. A study shows that if buildings complied with the exemplary energy performance criteria in BEAM version 1/96R, the savings could be as great as 32 percent; exemplary performance meeting BEAM 4/04 energy performance criteria would achieve even greater improvement. Through May 2005, there have been 100 buildings or over 60 million square feet of floor space assessed by BEAM. These include 52,000 residential units, equivalent to the homes of 150,000 people or slightly over 2 percent of Hong Kong's population. The numbers make BEAM the most widely used scheme of its kind in the world on a per capita basis.

Source: The HK-BEAM Society, see: http://www.hk-beam.org.hk/general/home.php

India: Green Rating for Integrated Habitat Assessment (GRIHA)

In India, most certified green buildings were rated under LEED. The LEED Green Building Rating System was developed around the premise that buildings are air conditioned, whereas in India, a large number of buildings built to date are not air-conditioned or partially air-conditioned. To bridge the demand for a rating system for non-air conditioned buildings while taking into account the possibility of a partially air conditioned building as well, The Energy and Resources Institute (TERI) has developed its own system known as GRIHA for the new large energy-consuming segment, i.e. commercial, institutional and residential buildings (new construction). This system responds specifically to India's prioritized national concerns about extreme resource crunches in the power and water sectors and rapidly eroding biodiversity. It attempts to stress passive solar techniques for optimizing indoor visual and thermal comfort and relies on refrigeration-based air-conditioning systems only in cases of extreme discomfort. There are 8 registered projects under GRIHA that are under construction. TERI is now developing a similar standard to address the needs of other building typologies such as existing buildings.

Source: The Energy and Resources Institute (TERI), India

Box 17: The U.S. Energy Policy Act of 2005: Financial Incentives for Building Energy Efficiency

Nationwide incentives for energy efficiency and conservation are considered a basic element of the energy policy formulated by the Bush Administration in the US. The Energy Policy Act (EPACT) signed into law in August 2005 offers consumers and businesses tax credits for energy-efficiency improvements in their buildings, among other incentives for energy users.

Home Energy-Efficiency Improvement Tax Credits

Consumers who purchase and install specific products, such as energy-efficient windows, insulation, doors, roofs, and heating and cooling equipment in the home can receive a tax credit of up to US$500 beginning in January 2006. The EPACT also provides a credit equal to 30 percent of qualifying expenditures for the purchase of qualified photovoltaic and solar water heating equipment used exclusively for purposes other than heating swimming pools and hot tubs. The credit shall not exceed US$2,000.

Business Tax Credits

Businesses are eligible for tax credits for building energy-efficient buildings, and for improving the energy efficiency of commercial buildings.

Building Energy Efficiency Improvement Tax Credits

Credit for business installation of qualified fuel cells, stationary microturbine power plants, and solar equipment. This provides a 30 percent tax credit of the purchase price for installing qualified fuel cell power plants for businesses, a 10 percent credit for qualifying stationary microturbine power plants and a 30 percent credit for qualifying solar energy equipment.

Business credit for energy-efficient new homes. This provides tax credits to eligible contractors for the construction of a qualified new energy-efficient home. The credit applies to manufactured homes meeting Energy Star criteria and other homes that save 50 percent of the energy compared to the EPACT standard.

Energy-efficient commercial building deduction. This provision allows a tax deduction for energy-efficient commercial buildings that reduce annual energy and power consumption by 50 percent compared to the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) 2001 standard. The deduction equals the cost of energy-efficient equipment installed during construction, with a maximum deduction of US$1.80 per square foot of the building. Additionally, a partial deduction of 60 cents per square foot is provided for building subsystems.

Energy-efficient appliances. This provides a tax credit for the manufacturer of energy-efficient dishwashers, clothes washers, and refrigerators. Credits vary depending on the efficiency of the unit. This is effective for appliances manufactured in 2006 and 2007.

Source: The U.S. Department of Energy, "The Energy Policy Act of 2005: What the Energy Bill Means to You", see: http://www.energy.gov/taxbreaks.htm plying the incentives is scarce, making a cross-country comparison of the approaches and results very difficult. However, experts have given several principles for the design of the financial incentive program.

David Goldstein, Energy Program Director of the Natural Resources Defense Council, reviewed the financial incentive programs in the U.S. and Europe, and concluded that incentive programs should satisfy the following design principles:[65]

- Economic incentives should be part of a comprehensive energy-efficiency package, and should be put in an energy-efficiency policy context that includes energy codes or standards, and energy performance labels.
- Financial incentives should be based on performance, rather than cost or price. Performance-based incentives depend only on meeting energy targets, while cost-based incentives depend on how much one spends on energy efficiency. Cost-based incentives have proven ineffectual or even counter-productive (tending to increase price or cost and inviting corruption), while programs based on performance and accompanied by strong promotion have been very successful (tending to increase competition and encourage innovation).
- Too small an incentive may not motivate decisions, while too big an incentive can become a budgetary problem for the government. In terms of what is the right size for an incentive, Goldstein thinks that incentive programs should be minimized by setting high goals and modest incentives; an incentive of 30-60 percent of expected incremental costs of compliance appears appropriate. Such an incentive may leverage the society's investment by 2-3 times.

One possible drawback of the incentive program is that it often attracts consumers who would carry out the investments even without the incentive, so-called "free riders" (e.g. high-income households get a tax credit for buying high-efficiency appliances they would have bought anyway). To correct these problems, the World Energy Council points out that incentives are better targeted to limit the consumer population that can benefit from them (e.g. low-income households, tenants), or restricted to certain types of investment (from a selected list of equipment), with a long payback time but high efficiency gains (e.g. renewables, cogeneration). They may also be restricted to innovative technologies (demonstration or exemplary investments).[66]

Lead-by-Example Programs

Government Modeling

Many buildings are owned and operated by governments. Government practices for procuring and operating buildings can influence market practice significantly. Governments can set a good example by requiring higher energy-efficiency thresholds for all new buildings and retrofitting existing ones. Using its weighty purchasing power, government can also stimulate markets for higher-efficiency products and technologies. For example, the Singapore government is planning to make it mandatory for all new public sector buildings and those undergoing major retrofitting to receive Green Mark certification.

Government modeling is common across Asia. In eight of the economies studied (China, Hong Kong, India, Japan, South Korea, the Philippines, Singapore, and Taiwan), energy-efficiency programs/requirements specifically target government buildings to make government the role model for implementing energy-efficiency technologies and practices (see Table 5 for an overview and Part III for the programs in each country).

Demonstration Projects

To stimulate market transformation, demonstration projects can be used to showcase technologies, practices, and effects of energy-efficient buildings.

Facilitating market transformation through demonstration projects is also common in Asia, and such projects are underway in eight of the 11 economies studied (China, Hong Kong, Japan, India, Malaysia, Singapore, Taiwan and Thailand) (see Table 5 for an overview and Part II for demonstration cases).

Industrial Capacity-Building

Programs such as targeted R&D, skill enhancement and training, energy performance benchmarking, demonstration projects, and energy audits can help build industrial capacity to meet new standards, provide a skilled workforce, and change how business leaders make decisions. These tools are utilized to different degrees in the 11 Asia economies examined (see Table 5 for an overview and Part III for the programs in each country).

Raising Public Awareness

Creating market demand requires basic consumer understanding about the importance of energy efficiency as a national—and global—goal as well as a money-saver that can be achieved without sacrificing comfort. An effective energy-efficiency awareness program is a low-risk and low-cost opportunity to lower a country's energy use. It involves a comprehensive information campaign that can support and reinforce the overall objective of building energy-efficiency initiatives. Education and awareness-raising is also a policy tool widely utilized in Asia (see Table 5 for an overview and Part III for the programs in each country).

Other Policy Tools

Apart from these policies targeted at the building sector specifically, other measures could be directed to building-related sectors and the broader energy sector. For example, several Asia Business Council respondents indicated the need for access to viable energy-efficient building materials. Policies to encourage the greening of the building material industry (e.g. environmental standards and labeling of building materials) might help facilitate further market transformation.

For the broader energy sector, energy pricing is a key factor determining the feasibility of energy-efficiency measures. Eliminating subsidies for electricity and other forms of energy that distort market signals is the most fundamental government action that benefits energy-efficiency activities, although the move from subsidized prices to market-based prices can be a difficult transition.

Richard Newell, Adam Jaffe, and Robert Stavins at Harvard College and the Massachusetts Institute of Technology investigated econometrically the factors affecting the energy-saving technology innovation of a number of appliances/equipment, including water heaters and central and room air conditioners, and found that up to half of the improvements in the average energy efficiency of these products in the U.S. during the period of the 1950s to 1990s have been associated with rising energy prices.[67] In Japan, the most energy-efficient developed country, the government used the Energy Conservation Law to raise the cost of gasoline and electricity far above market levels to force households and companies to conserve.[68] These tax revenues were in turn used to help Japan take the lead in investing in developing solar power and other renewable energies, and, more recently, home fuel cells. Such pricing policy has contributed significantly to its substantial success in restricting energy consumption on the demand side and in developing renewable energy resources (see Part III for energy-efficiency policies in Japan).

Integrated Approach in Policy Making

An integrated approach to building energy-efficiency policies, in which a number of policies are combined to create both supply push and demand pull, can be more effective than any one in isolation.[69] For example, building standards work best in coordination with financial incentives and industrial capacity-building. Standards push the market by setting up the minimum performance requirements while incentives encourage compliance with standards and industrial capacity-building tools help the industry to meet new requirements.

The EU Directive on Energy Performance of Buildings is a case in point: it integrates a variety of policy tools to promote the energy performance of buildings in member states. The directive requires the application and regular updating of minimum standards in new buildings and certain renovated buildings. These standards require, for example, energy performance measurement of buildings, advice for owners of new and existing buildings, inspection and assessment of boilers and heating/cooling systems, etc.[70]

The right mix of policy measures necessarily varies by country and is influenced by a country's level of development, cultural factors, government efficacy, climate situations, and the like. As Asia is comprised of a wide diversity of economies, there is no standard "right" policy composition that might be appropriate to every country's context. However, the typical policy tools that are being used worldwide, as shown here in Table 4, constitute an extensive policy matrix on which Asian economies may base their own policy mixes.

In Asia, Japan and Singapore are the leaders in designing building energy-efficiency programs that cover most stages of a building's life cycle and target both the suppliers and users of buildings. South Korea, Taiwan, and Hong Kong follow, with China since 2004 making substantial progress toward establishing building energy-efficiency programs.

The Enforcement Challenge

Unlike air conditioners or rice cookers, buildings are custom-built unique objects, requiring independently verified compliance with design elements. The easiest way to enforce energy standards is to incorporate them into the general building standards that govern all aspects of building construction (e.g. sanitation, fire protection and structural integrity). Yet, even in countries where general building standards are enforced, enforcement of energy standards can be lax. Relative risk and resources are the primary issues. When it comes to structural standards for safety, if something goes wrong, lives may be at stake. For energy, if the standard is not enforced, the risk is much lower so governments typically devote fewer resources to energy standard enforcement.

The Asia Business Council study finds that while all 11 economies covered in the study have building energy standards on paper, most economies have failed to produce significant energy savings (see Part III). For example, the Chinese government estimated that only 20 percent of buildings opened since 1996 comply with energy standards already in place.[71] The World Business Council on Sustainable Development is even grimmer, estimating that only 10 percent of China's buildings meet the country's own energy standards.[72]

An effective standards enforcement system requires many elements:

- Development of compliance manuals, forms, and compliance software;
- An institutional framework with well-defined authority, responsibility and well-trained officials;
- An appropriate combination of incentive and penalty mechanisms;
- Effective monitoring and verification systems;
- Effective education and information distribution systems; and
- Demonstration projects that show the cost and effect of energy-efficiency measures.

Effective enforcement of standards requires not only well-designed policies but also the political will and well-established institutional infrastructure to enable the market transformation toward more efficient buildings. As Farrell, Nyquist and Rogers from McKinsey commented, "It would be far from easy to implement the remedies: removing policy distortions, making the price and usage of energy more transparent, and selectively deploying demand side energy policies such as building standards and efficiency standards for appliances. But if policy makers muster the political will to put incentives in place, and if businesses and consumers respond, the results will be dramatic."[73]

Table 4: Policy Tool Kit for Market Transformation: Lessons Learned and Asian Examples

POLICY TYPE	DESCRIPTION	CHARACTERISTICS OF EFFECTIVE PROGRAMS	LEADING EXAMPLES IN ASIA
Minimum Energy Performance Standards • Appliances/ Equipment • Buildings	Shift the distribution of energy-efficient models sold in the market upward by removing most inefficient offerings Foundation of most energy efficiency programs world-wide Well documented track record globally	Mandatory Financially feasible for majority of market and harmonized with international standards Industry involved in development Legal framework, compliance infrastructure, skilled staff Testing procedures and protocols for appliances and equipment Provide regulatory certainty and drive innovation through regular standards revision Industry awareness-raising Government procurement/tenancy Complemented by R&D	**Appliance/Equipment** Japan: unique Top Runner program widely recognized as innovative and effective South Korea: aggressive and comprehensive implementation with corresponding results **Buildings:** Singapore, Japan, Taiwan, South Korea all have comprehensive building standards, established compliance and required implementation skills
Labeling of energy performance • Appliances/ Equipment • Buildingss	Enables consumers to include energy efficiency in buying decisions Stimulates producers to differentiate their product offering by achieving higher ratings	Mandatory once program established Clarity of labeling Industry involved in development Legal framework, compliance infrastructure, skilled staff Testing procedures and protocols for appliances and equipment	**Appliances/Equipment** South Korea: aggressive and comprehensive implementation, also high-efficiency equipment certification program Thailand: Unique utility-led appliance labeling program

	Proven complement to minimum energy standards for appliances and equipment Emerging trend for buildings – scope often extends beyond energy performance (e.g. green buildings)	Industry and consumer awareness-raising Government procurement/tenancy Financial incentives or financing	**Buildings:** South Korea: label for superior energy performance for new and existing residential buildings Singapore: label for achievement of superior energy performance and meeting IAQ requirements for new buildings Japan and Hong Kong have labeling systems which include energy performance along with other measures
Financial Incentives[1]	Financially valuable incentives stimulate investment in energy performance beyond minimum required standards Signal the market of future regulatory intent May also be used to stimulate demand for energy-efficient consumer products	Incentives based on performance, rather than cost or price Designed to complement energy standards, labeling programs, etc. Valued by target sector Program accompanied by promotion/awareness raising Costs minimized by setting high goals and modest incentives: 25 percent-50 percent of incremental market price. Simple to understand and administer Accurate reporting and tracking of program results Compliance recognized with labels or ratings	South Korea: incentives linked to building certification levels for new and existing buildings and certification of high efficiency equipment Singapore: incentives linked to green building certification levels and for upgrading of equipment Japan: support for housing efficiency upgrades Taiwan: rebates for installation of solar hot water systems Thailand: unique ENCON fund derived from petrol tax and used to further energy efficiency objectives

Table 4: Policy Tool Kit for Market Transformation: Lessons Learned and Asian Examples (Continued)

POLICY TYPE	DESCRIPTION	LEADING EXAMPLES IN ASIA
Industry-Capacity Building	Designated Centers of Excellence charged with information distribution, technical guidance and research in support of policy development	South Korea (KEMCO), Hong Kong (EMSD), Singapore (NCCC) and Malaysia (PTM)
	Public or public/private projects to raise industry awareness of improved or new technologies or to demonstrate design compliance with new standards	Malaysia: Securities Commission Building, LEO and ZEO public demonstration buildings China: MOST public demonstration building, (LEED gold) and pilot cities for energy management programs Singapore: National Library public building (Green Mark Platinum) India: CII-Godrej Green Building Center public/private partnership (LEED platinum) Hong Kong: EMSD government building
	Energy performance benchmarking to allow building owners to evaluate performance levels and a vital input to policy making and tracking	Hong Kong and Singapore have energy benchmarking initiatives which aid both building owners and policy makers
	Skills enhancement such as industry training programs	Singapore Energy Training Program for Energy Efficient Building Management Japan: voluntary training of construction techniques linked to newest building standards Hong Kong: provision of technical and financial analysis to increase industry awareness and understanding

	Building Audit Programs	Hong Kong: Extensive auditing of government buildings with the findings being used to develop guidelines and recommendations for the private sector South Korea, Singapore, Thailand, energy audits target building segments
	Government Modeling	Singapore Taiwan – mandatory green building certification for government-funded new construction South Korea: mandatory energy savings plans with semi-annual reporting Hong Kong: mandatory energy audits for government buildings Philippines: energy reduction targets and ratings
Education and Awareness-Raising	Public advertising to establish link between the users' behavior, energy savings and the environment	Most economies have some form of public awareness campaigns; the most well-known is probably Japan's "Cool Biz" campaign
	Education of children, media, politicians; via school curriculum, exhibitions, seminars, forums, conferences, etc.	Many economies have some form of educational outreach targeted to government officials, school age children, and/or specific industry segments

Generally, implementation of building energy-efficiency policies in most Asian economies is still in a very early stage of development compared with leading countries worldwide. A well-established institutional infrastructure that might support the implementation of building energy standards is yet to be established.

Within the region, however, the Asia Business Council's extensive review of related reports and interviews with experts in this field points out the following trends:

- Japan, Singapore, South Korea and Taiwan are the leading economies where the standards are now well-accepted as basic building requirements, with rigorous voluntary programs going beyond that base. Among the four leading economies, standards in South Korea, Singapore and Taiwan have been mandatory since their first version and have been strongly enforced, while the Japanese standard is voluntary, but with a high rate of compliance.
- In Hong Kong, followed by China and Thailand, standards have been developed and are in the early stages of implementation while efforts to go beyond the standards are still weak.
- In India, the Philippines, Malaysia, and Indonesia, standards have been developed, but implementation plans are still being developed.

Industrial Associations and NGOs: Catalysts for Market Transformation

Unlike Western countries where industry-driven initiatives are one of the leading forces driving the market transformation toward greater sustainability in the built environment, industry associations in Asia have to date not played a leading role, leaving initiatives largely to government. In fact, the role of non-government organizations (NGOs) can go beyond purely monitoring and criticizing the government and industry, or just setting good examples through the choices they make. Organizations such as industry associations, research institutes, universities, chambers of commerce, environmental organizations, and consultants can act as catalysts for actions by all stakeholders.

In this regard, the U.S. Green Building Council (USGBC), a non-profit association of around 9,500 members from every sector of the building industry, has provided an excellent example. Besides developing and refining the LEED Green Building Rating System, the USGBC has created a variety of programs to promote the green building movement in the U.S. and the world. These include providing educational offerings on every aspect of green building targeted at professionals in the building industry, students and the general public through courses, workshops, conferences and exhibitions; awarding accreditations to professionals and buildings; and establishing a nationwide network of green building experts (see Box 18). Since 2000, USGBC's membership has increased ten-fold. As of June 2007, USGBC had issued LEED certifications to around 900 projects in 24 countries, and there are more than 6,800 registered projects that are waiting for a LEED rating; LEED workshop attendance has reached around 47,000, and more than 37,000 people have gained LEED Professional Accreditation. In 2006,

Box 18: The US Green Building Council and Its Programs

The USGBC is a non-profit composed of around 9,500 memberss, including corporations, governmental agencies, nonprofits and others, from every sector of the building industry working to "promote buildings that are environmentally responsible, profitable and healthy places to live and work". It's a pioneer that has been leading the global green building movement. Besides developing and refining the LEED Green Building Rating System, the USGBC has created a variety of solid programs to promote the green building movement in the US and the world. Its key programs include:

LEED Green Building Rating System
The USGBC developed LEED, a green building rating system for developing high-performance, sustainable buildings that has been adopted by buildings in 24 countries (see Box 2 on pages 20-21). USGBC's members, representing every sector of the building industry, developed and continue to refine LEED.

Chapter Program
USGBC has a strong network of 75 regional chapters throughout the U.S. USGBC chapters provide local green building resources, education and leadership oppor-

Box 18 Continued

tunities. Local chapter members can connect with green building experts in their area, develop local green building strategies and tour green building projects.

Education and Advocacy
USGBC provides educational on green design, construction, and operations for professionals from all sectors of the building industry. More than 50,000 designers, builders, suppliers and managers have attended USGBC educational programs.

LEED Professional Accreditation
LEED accreditation is awarded to building industry practitioners who successfully demonstrate these proficiencies in a comprehensive exam. A LEED Accredited Professional is an individual who has earned the distinction of demonstrating the ability to serve on a LEED project team and provide detailed knowledge of LEED project certification requirements and processes and also has a command of integrated design principles.

LEED Workshops
More than a dozen workshops are conducted monthly in the US by the USGBC. It also offers LEED topic modules which are tailored, half-day sessions addressing the broad needs of LEED users by exploring topics specific to individual building types or areas of professional practice as well as critical market issues such as the economics of LEED-certified projects.

Online Courses
USGBC currently offers the "Essentials of LEED Professional Accreditation," an interactive online course developed in partnership with Turner Construction Company. The course builds upon a basic knowledge of the LEED Rating System and covers the range of topics that building industry professionals should know to successfully manage the LEED project certification process.

Greenbuild International Conference & Expo
The USGBC's Greenbuild International Conference & Expo is the world's largest conference on high-performance building practices. Key themes include new products, innovative projects and the latest building research.

Emerging Green Builders Program
The Emerging Green Builders program provides educational opportunities and resources to students and young professionals with the goal of integrating these future leaders into the green building movement.

Educational Partners and Affiliates
Partnering with qualified training providers, the Educational Partner program promotes training offerings serving the continuing education needs of the rapidly evolving green building industry.

Source: The US Green Building Council, see: www.usgbc.org the USGBC Greenbuild (an international conference and exhibition) attendees reached around 13,400. With such wide influence, LEED has been playing a leading role in the global green building movement.

For industry associations in Asia, particularly those in the construction industry, their role includes:

- Educating themselves and setting good examples for society through the choices they make;
- Learning as much as possible about their role and impact on building energy-efficiency improvement in the society;
- Raising awareness among industry, public, and the government of built environment sustainability;
- Helping build industry capacity through providing professional and technological expertise or getting companies in touch with other organizations that may help through establishing networks of experts;
- Developing new or promoting existing energy-efficiency rating and benchmarking systems as standards for building construction;
- Helping the government in building energy-efficiency policy-making; and
- Providing resources, education, and opportunities for green building improvements in the society.

These actions may catalyze market transformation in Asia, where the potential for energy efficiency is largely untapped.

Table 5: Overview of Building Energy Efficiency Policies in Asia

	CHINA[1]	HONG KONG	INDIA[1]	INDONESIA	JAPAN	MALAYSIA
Minimum Energy Performance Standards						
Appliances/Equipment	●(23)[2]	—	❍(3)	●(10)	●(2) ❍(21)	●(5) ❍(1)
Buildings	●	●	● (P)[3]	❍	❍[4]	❍
Labeling of Energy Performance						
Appliances/Equipment	●(2) ❍(36)	❍(20)	❍(9)	❍(5)	❍(30)	❍(7)
Buildings	❍	❍	❍	—	❍	—
Green Building Rating & Certification	❍	❍	❍	—	❍	—
Financial Incentives						
To Stimulate Performance/Supply	P	—	—	?	✔	✔
To Stimulate Demand	P	✔	—	?	✔	✔
Industry-Capacity Building						
Centers of Excellence	✔	✔	✔	?	?	✔
Energy Performance Benchmarking	—	✔	—	—	?	✔
Skills Enhancement	✔	?	✔	?	✔	✔

Sponsored R&D	?	?	—	?	?	?
Building Audit Programs	?	—	✔	—	✔	✔
Leading-by-example Programs						
Government Modeling	✔	✔	✔	—	✔	?
Demonstration Buildings	✔	✔	✔	?	✔	✔
Consumer Awareness-Raising						
Public Advertising	?	✔	✔	?	✔	?
School Education Programs	?	✔	?	?	✔	✔
Policy Implementation						
Enforcement Infrastructure	P	✔	—	—	✔	—

● Mandatory ❍ Voluntary ✔ Have Program P Planned ? Unknown — None/Limited

Notes

1. Programs and enforcement vary by province/state. This inventory of policy is based on national programs and does not capture the activities of specific progressive regions within these economies.
2. Numbers in parentheses show the types of appliances/equipment covered by the program.
3. India has drafted a standard (the ECBC) which is "intended to be mandatory" subject to its adoption by each state. This process has just started.
4. At the time of writing the standards were voluntary but the government has stated plans to make them mandatory in 2007.

Table 5: Overview of Building Energy Efficiency Policies in Asia (Continued)

	PHILIPPINES	SINGAPORE	SOUTH KOREA	TAIWAN	THAILAND
Minimum Energy Performance Standards					
Appliances/Equipment	●(8)	●(1)	●(16)	●(12)	●(9)
Buildings	●	●	●	●	●
Labeling of Energy Performance					
Appliances/Equipment	●(11) ❍(1)	❍(20)	●(15) ❍(17)	❍(28)	●(2) ❍(18)
Buildings	?	❍	❍	❍	?
Green Building Rating & Certification	P	❍	❍	❍	—
Financial Incentives					
To Stimulate Performance/Supply	?	✔	✔	?	✔
To Stimulate Demand	?	—	✔	✔	?
Industry-Capacity Building					
Centers of Excellence	—	✔	✔	?	✔
Energy Performance Benchmarking	—	✔	?	✔	?
Skills Enhancement	✔	✔	?	?	✔

Sponsored R&D	?	✔	?	?	?
Building Audit Programs	—	✔	✔	✔	✔
Leading-by-example Programs					
Government Modeling	✔	✔	✔	✔	?
Demonstration Buildings	—	✔	?	✔	✔
Consumer Awareness-Raising					
Public Advertising	✔	✔	?	✔	✔
School Education Programs	✔	✔	?	?	?
Policy Implementation					
Enforcement Infrastructure	—	✔	✔	✔	—

● Mandatory ❍ Voluntary ✔ Have Program P Planned ? Unknown — None/Limited

Notes

1. Programs and enforcement vary by province/state. This inventory of policy is based on national programs and does not capture the activities of specific progressive regions within these economies.
2. Numbers in parentheses show the types of appliances/equipment covered by the program.
3. India has drafted a standard (the ECBC) which is "intended to be mandatory" subject to its adoption by each state. This process has just started.
4. At the time of writing the standards were voluntary but the government has stated plans to make them mandatory in 2007.

The Future for Building Energy Efficiency

Over the last ten years, the world has increasingly focused on the need for improved energy efficiency within the built environment. Increasing concern over energy security, environmental damage, climate change, and health issues associated with the quality of our indoor environment are driving a global trend toward greater efficiency in the built environment.

In Asia, the combination of unprecedented economic growth, rapidly increasing affluence, accelerating industrialization and urbanization, and continued population growth create both a unique opportunity and a significant policy challenge. Unlike more developed regions, Asia is adding to its built environment and energy infrastructure at a tremendous rate. With over half the world's new construction in the next decade expected to take place in Asia, the region has a unique opportunity to shape that growth, so that the properties built today require far less energy than existing stock. Designing a building to be energy efficient is the most cost-effective approach, with developers able to build a commercially viable structure that is at least 30 percent more energy-efficient than buildings with comparable features. Demonstration buildings around the world are furthering the viability of the zero-energy building. Asia is uniquely positioned to deploy these latest achievements as it designs new communities and extends energy infrastructure throughout the region.

The challenge is the competition for political attention in a region struggling to manage growth, globalization, political maturation and poverty alleviation. Investment in energy efficiency is more cost-effective than investment in power generation yet the latter provides a faster fix. Even widespread success will not translate directly into an equivalent reduction in energy consumption. Rather it will serve to offset the certainty of rapidly increasing per-capita energy consumption associated with growing affluence. The absence of a focused effort by both the public and private sectors will almost certainly lead to an increasing drag on regional GDP growth, caused by increases in energy prices and declines in the quality and availability of natural resources.

The benefits of energy efficiency are a composite of community goods—those benefits that accrue to a nation as a result of cumulative efforts—such as improved national energy security, reduced environmental strain, and enhanced export competitiveness, and those that benefit a company or individual directly—such as cost savings, enhanced company reputation, product/service differentiation, and staff motivation.

Market failures largely constrain the business case for investments in energy performance to public and private owners who retain responsibility for all the operating costs of their buildings, thus limiting the realization of broader community benefits. Several decades of experience in more developed countries have shown the positive impact that regulatory intervention can have in speeding adoption of energy-conscious business management.

Overall, Asian economies increasingly view energy efficiency as a key measure to address energy and environmental challenges, and improving energy efficiency has become one of the main national energy policy objectives across Asia. Specifically, the growing impact of buildings on the Asian energy outlook is driving this region to explore the means for greater building energy performance. Unlike Western countries, where industry-driven initiatives are the leading forces

Table 6: Overview of Recommendations to Different Stakeholders

STAKE HOLDERS	SCOPE OF INFLUENCE	LEADERSHIP ACTIONS
Developers/Owners	New building project objectives, budget and design team selection Capital budgets for upgrades of existing buildings Selection and policy setting for building management	Build or buy expertise Make energy efficiency a part of the design brief Pursue integrated design Right-size key building systems Commission the building to realize energy efficient savings Make efficient operations part of the building operations strategy Set targets and align budgets Adopt lifecycle costing Plan and implement energy-conscious building upgrades
Developers/Owners	Building systems efficiency Tenant awareness-raising	Adopt energy management best practices Establish energy measurement and monitoring tracking Set targets and align budgets Adopt lifecycle costing Assess operations and maintenance Invest in skills development
Occupants	Appliance efficiency Staff awareness-raising	Adopt energy management best practices Increase staff awareness Ensure energy-efficient procurement

Governments	Policy setting and enforcement Public awareness-raising Creation of a level playing field Capacity-building Example-setting	Establish regulatory minimums for energy performance Provide incentives for performance beyond regulatory minimums Demonstrate best practices and adopt higher requirements for public buildings Build capacity through investments in skills enhancement and education and sponsored R&D Raise public awareness of the link between energy conservation and the environment and national security
Industrial Associations and NGOs	Catalyst for action by all stakeholders	Educate selves and set good examples Raise awareness among the industry, public, and the government Help build industry capacity through providing professional and technological expertise or getting companies in touch with other organizations that may help through establishing networks of experts Develop new or promote existing energy efficiency rating and benchmarking systems as standards for building construction Help the government in policy-making Provide resources, education, and opportunities for green building improvement

driving the market transformation, Asian governments are taking the lead. There have been substantial government initiatives in promoting building energy efficiency in this region in the past decades, particularly since 2000. In general, the region is turning to stricter guidelines and requirements for building energy efficiency and, recently, sustainable or green buildings. These policy initiatives signify the very beginning of a transformation that might change gradually the way buildings are designed, built, and operated in Asia.

But the role of improving energy efficiency must not be left to the government alone. The government's primary role is to increase awareness, create a level playing field and build capacity. Business leaders, from developers and owners to operators and occupants, can then leverage this policy framework to achieve energy savings and strengthen their companies' position. In fact, many energy-saving initiatives for existing buildings can be achieved with little or no cost. For developers/owners, passive and integrated design techniques are the key to maximize the energy efficiency in new building design or existing building retrofit, while for operators and occupants, the starting point is to make energy management a business priority. For all stakeholders, the use of life-cycle cost analysis must be the basis of decision making. In so doing, they will improve the cost effectiveness of their company and enhance their organization's attractiveness as an employer and as a steward of Asia's future.

PART II – ENERGY-EFFICIENT BUILDINGS IN ASIA

Asia has a growing number of energy-efficient buildings. This section highlights a number of them. We have included representative buildings from each of the 11 Asian economies where the Asia Business Council has members. This list is not intended to be exhaustive, but to give a sense of the range of buildings that use energy more efficiently. We have included both cutting-edge as well as more mainstream examples. Several are government buildings or are built with some form of government support with the explicit aim of demonstrating the effectiveness and economic efficiency of these designs.

One theme that emerges from these examples is what a big difference small adjustments can make. Using energy more efficiently in buildings requires a strong commitment from the top. And it is important to get the big pieces of energy-using equipment right—the proper size and operated as efficiently as possible. But getting the small things right—like lights and exhaust fans in parking garages, lights on fire stairs, natural lighting and natural ventilation—can add up to big efficiency gains. Eking out these gains also requires giving operating staff the training and tools to make needed changes as well as the freedom and the incentives to experiment.

Unfortunately, much of the relevant data is fragmentary, reflecting in part the reality that commercial buildings are not managed as scientifically as, say, factories. Wherever possible, we have endeavored to contact those involved with developing or managing the buildings. In many cases, however, we have relied exclusively on secondary sources, such as web sites, often at the request of the building management. But there is little doubt from these examples that real energy savings accrue with little additional cost.

China

Agenda 21 Demonstration Energy-Efficient Office Building

Source: Joe Huang, principal technical advisor for the schematic design of the Agenda 21 Demonstration Energy-Efficient Office Building

The Agenda 21 Demonstration Energy-Efficient Office Building was a joint effort of the Chinese Ministry of Science and Technology (MOST) and the U.S. Department of Energy. One of the goals of this project is to demonstrate that significant additional energy savings beyond the existing building energy standard in China are achievable in ways that are replicable and cost-effective in China's emerging buildings market. Joe Huang, technical advisor to the Asia Business Council on this research project, was the principal technical advisor for the schematic design of this building.

The building is located in the western part of downtown Beijing, overlooking Yuyuantan Park, the second largest green space in the metropolitan area. It has nine stories, with a total floor area of 13,000 square meters. Ground-breaking took place in February 2002, and it was completed in the first half of 2004. It is now the headquarters building of the MOST.

The building is intended to demonstrate significant cost savings without using the most advanced technologies. The building design focuses on so-called "state-of-the-shelf" technologies (technologies that are advanced but already commercialized) and techniques that are either currently cost-effective, or likely to be so under market conditions that are likely to develop. At the same time, the project is flexible about showcasing more innovative technologies. If suitable opportunities arise, the project will incorporate emerging technologies into small portions of the building on a limited basis.

The building has a number of energy conservation features, including both building envelope and mechanical system measures. A cross-shaped building design was used to maximize daylighting potential, with windows located on the north and south facades to better control solar heat gain. A whole-building or integrated-design approach was used to identify the most cost-effective energy strategies for this building, including passive solar and other clean energy options such as photovoltaics (PVs) and geothermal power systems. Other cost-effective efficiency measures include:

- Light colored wall and roof surfaces;
- Recessed windows;
- High-efficiency lighting;
- Low-emissivity (low-e) window glazing;
- Bi-level light switches (daylighting);
- Reduced window height;
- Staged chillers; and
- Improved chiller efficiency.

Measured performance data indicated that the building is much more energy efficient than similarly equipped office buildings in East Asia and the U.S. In the feasibility study, the building design was estimated to be 40 percent more efficient than ordinary buildings. In the LEED analysis, it was found to be 60 percent more efficient than the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1 energy budget benchmark and earned the full 10 points in the optimal energy performance section of LEED. The utility data from the first year's operation match well the LEED analysis results, providing that adjustments are made for unexpected changes in occupancy and operations. Compared with similarly equipped office buildings in Beijing, this demonstration building uses 60 percent less energy per meter of floor area. (Significantly, however, given the pace of construction in China, the building uses slightly more energy per meter of floor area compared to conventional office buildings with less equipment and window air-conditioners.) Most of the energy features in this building are very attractive in the Chinese building market. In 2004, China's Ministry of Construction gave the building its top award for best green building in China. In 2005, the building received the first LEED Gold rating for a building in China.

Source: Joe Huang, a scientist at Lawrence Berkeley National Laboratory, the principal technical advisor for the schematic design of the Agenda 21 Demonstration Energy-Efficient Office Building, and technical advisor to the Asia Business Council in this research project.

TaiGe Serviced Apartments

Source: China Merchants Real Estate Co.

TaiGe is the first LEED-certified (Silver) commercial development in China. It is a high-end serviced apartment complex in the Shekou District of Shenzhen, consisting of a 25-story main building and six 4-6-story low-rise buildings with a total floor area of around 34,000 square meters and providing more than 230 apartments. The complex was developed in 2004 by China Merchants Property Development Co., Ltd. (CMPD), a subsidiary of China Merchants Group Ltd., a conglomerate founded more than 100 years ago.

According to Hu Jianxin, Deputy General Manager of CMPD, TaiGe is a demonstration project that incorporates many green building features for water and energy savings, waste recycling, and a better indoor environment. For example, high-performance chillers with an energy recovery system and low-emissivity window glazing are used to save energy. Theoretically, TaiGe can save 75 percent of lighting power consumption and 50 percent of air-conditioner power consumption per square meter per hour compared with hotels to achieve the same brightness and temperature. "We see green property development as the way to achieve our corporate values, which consist of three elements: historical mission, social responsibility, and caring for human beings," Hu told the Council researchers when asked why CMPD initiated the green project.

TaiGe has targeted international professionals or senior staff working in multinational corporations in this area, who are more environmentally conscious, as renters. Hu said the project has turned out to be very successful financially. He told researchers that the rent of TaiGe is around 15 percent higher than CMPD's initial expectation, an expectation that itself was already higher than the market price.

The success of TaiGe has gained attention from both local and national governments. It was one of the five residential projects of the Department of Construction's building technology demonstration, and was listed in the Guangdong government's Green Residential Building demonstration projects.

Source: Interview with Hu Jianxin, Deputy General Manager of China Merchants Property Development Co., Ltd., July 2006, Shenzhen, China.

Pearl River Tower

Source: Skidmore, Owings & Merrill LLP

The Pearl River Tower, which has been under construction since 2006 in Guangzhou, will be occupied by the China National Tobacco Corporation when finished in 2009. It is designed to be one of the first zero-energy buildings in the world. It will be 303 meters (994 feet) tall with 69 floors and a total floor area of more than 212,000 square meters.

This building takes advantage of both high energy-efficiency building design and solar and wind power to generate energy for its consumption. Among its features are turbines that turn wind into energy for the HVAC system. According to building designer Skidmore, Owings & Merrill, the building's facade was designed to accelerate the wind as it moved through the opening in the building. Skidmore, Owings & Merrill initially estimated that the design would increase wind velocity to 1.5 times ambient wind speeds. In tests, models showed wind speeds of up to 2.5 times ambient wind speeds in some cases. If this proves the case during actual operation, the building could generate power 15 times greater than a freestanding turbine. The turbines do more than generate electricity, though. The openings through which the wind flows help reduce the overall wind load on the skyscraper.

Other green features of the building include a solar collector for more power generation, and a rainwater collection system, part of which is heated by the sun to provide hot water. The building is cooled, in part, through heat sinks and vertical vents. Indeed, it is intended that these systems will generate more energy than the operation of the building will use.

Source: Preston Koerner, 2006, "Pearl River Tower, Guangzhou, China", JETSON GREEN, August 13, see: http://jetsongreen.typepad.com/jetson_green/2006/08/pearl_river_tow.html; World Architecture News, "Innovative form embraces wind", see: http://www.worldarchitecturenews.com/index.php?fuseaction=wanappln.projectview&upload_id=462

Dongtan Eco-city

Source: Web site of Arup & Partners Hong Kong Limited, see: http://www.arup.com/

Dongtan Eco-city, a project currently being planned and designed, is the world's first sustainable city envisioned to be as close to carbon-neutral as is economically possible.

At three-quarters the size of Manhattan and located on Shanghai's Chongming Island, the third largest island in China at the mouth of the Yangtze river, Dongtan will be developed on 630 hectares of land as a sustainable city to attract a range of commercial and leisure investments. The site is adjacent to a huge wetland of global importance, so ecologically sensitive design will be a key element of the master plan.

Energy demands in Dongtan will be reduced by specifying high thermal performance standards for all new buildings and using energy-efficient equipment and mechanisms. Dongtan will produce its own electricity and heat from renewable sources, including a combined heat and power (CHP) plant that runs on biomass in the form of rice husks from local rice mills; a wind farm; and biogas produced from municipal solid waste and sewage. Individual buildings will have their own photovoltaic cells and micro wind turbines.

To be truly sustainable, the city must not only be environmentally sustainable, but socially, economically and culturally sustainable too. All housing in Dongtan will be within seven minutes' walk of public transport and offer easy access to social infrastructure such as hospitals, schools and work. Organic farming methods will be used to grow food for the Dongtan inhabitants and land will be fertilized using processed waste from the city.

The project sponsor is the Shanghai Industrial Investment Corporation (SIIC), which is partnering with Arup, an international design and consultancy firm, in the planning and design. The first phase of development for up 10,000 people should be in place in time for the Shanghai World Expo of 2010.

Sources: Raymond M.H. Yau and Andrew K.C. Chan, 2007, "Towards Delivering a Sustainable Dongtan: Dongtan—21st Sustainable City", presentation at the conference: "International Conference on Climate Change", May 29-31, Hong Kong; web site of Arup & Partners Hong Kong Limited, see: http://www.arup.com/

Hong Kong

Sunny Bay MTR station

Source: Jerry Crimson Mann on Wikimedia Commons

The Sunny Bay Mass Transit Railway (MTR) station is one of two stations on the Hong Kong MTR Disneyland Resort Line. Unlike other MTR stations in Hong Kong, the Sunny Bay station uses minimal energy because of its passive design features. It has no air conditioning and instead makes use of the natural environment to control the temperature and lighting inside. By using a canopy to harness the natural flow of the air for cooling, Sunny Bay has removed the need for most of a normal station's mechanical and electrical systems. These systems account for 30 percent of the capital cost of a typical building in Hong Kong. The canopy drops the air temperature by two degrees Celsius, which usually is enough to make people feel comfortable. During the day, the translucent material lets light in and at night high-efficiency lighting is used, allowing the station to cut 75 percent from the lighting cost of a typical station in Hong Kong. The architecture firm Aedas won the Hong Kong Institute of Architects Merit Award (2005) and the Green Building Grand Award (2006) from Hong Kong's Professional Green Building Council for its station design.

Source: Web site of Aedas, see: http://www.aedas.com; Barclay Crawford, 2006, "Green Street," South China Morning Post, 28 November.

Cityplaza III and IV

Source: Swire Properties

In the late 1990s, Swire Properties adopted a series energy-efficiency improvement measures to two of its grade-A office buildings, Cityplaza III and IV. These improvements include:

- Retrofitting of energy-saving light fixtures;
- Different lift programming suited for variable passenger flow;
- BMS control of lighting in back of house and loading bay areas;
- Installation of capacitor banks for power factor improvement in lift systems; and
- Installation of variable frequency drives for air handling units and primary air handling units.

By adopting these energy-efficiency measures in these two buildings at a cost of some HK$3 million (around US$380,000), building operators have realized annual savings in electric bills of around HK$1 million (around US$130,000), or 8 percent of annual operational energy costs. The investment was paid back in approximately 3 years. In 2001, these environmental achievements were recognized with the highest BEAM (Building Environmental Assessment Method) rating of Excellent (See later section for more about BEAM).

Source: HK-BEAM Society, see: http://www.hk-beam.org.hk/caseStudies/existing.php

Festival Walk

Source: Chong Fat on Wikimedia Commons

Festival Walk is a mixed-use commercial complex building featuring a shopping mall, an office tower, and related entertainment and amenity facilities, with a total floor area of about 130,000 square meters. The building was completed in 1998 by Swire Properties and has since been run by Swire Properties Management.

In 2003, Festival Walk became the largest commercial building in Hong Kong that converted its air-cooled air conditioning system to a more efficient water-cooled system. But what makes this building even more notable is the adoption in 2004 of an innovative chiller control strategy for the water-cooled air conditioning system that saves energy with minimal investment. Although the conversion to water-cooled chillers from air-cooled ones in 2003 made the air conditioning system more energy-efficient, technical staff of Swire identified a shortcoming in the control logic of the new system that compromised its energy performance.

In a conventional system, a computerized pre-set constant chilled water flow rate passes through each of the chillers. The more cooling needed, the more chillers will be activated. When a pre-set deficit flow rate is detected in the chilled water loop, an additional chiller is activated. This setup can waste energy if the chiller already in operation has not reached its maximum cooling capacity and thus triggers the operation of an additional chiller.

After monitoring data, a new control strategy was developed. The new control strategy minimized this mismatch of cooling load demand and chilled water flow demand. The investment was minimal since it only required modification of the program logic, but the annual energy savings can reach approximately 400,000 kWh and reduce the release of CO_2 by 240,000 kg.

The project demonstrated the potential energy savings in existing buildings that can be achieved by improving the building management system with minimal investment. This achievement was recognized by the Hong Kong Eco-Business Award (2004) and the ASHRAE Technology Award (2006).

Source: Interview with Cary W.H. Chan, Head of Technical Services, Swire Properties Management Ltd, July 2007, Hong Kong.

India

CII-Godrej Green Business Center Building

Source: Godrej & Boyce Manufacturing Co., Ltd.

The CII-Godrej Green Business Center (CII-Godrej GBC) Building is the office of CII-Godrej GBC, a joint initiative of the Government of Andhra Pradesh, Confederation of Indian Industry (CII) and Godrej, with the technical support of USAID. It is an unique model of a successful public-private partnership that is dedicated to promote efficiency and equitable growth leading to sustainable development.

The building is the first green building in India. It is the first LEED Platinum-rated building outside the US, and was the most energy-efficient building *in the world* at the time it was rated. It was built to promote the green building concept and demonstrate that India can build to global environmental standards. The building incorporated such features as water efficiency, energy efficiency and construction waste recycling. According to CII-Godrej GBC, the building is capable of reducing its total energy consumption by 55 percent and its lighting energy consumption by 88 percent.

The building is centered around a circular courtyard, with a series of smaller interior courtyards. Energy-efficiency features of this building include:

- North light for indoor daylighting: Almost 90 percent of the interiors are day-lit, with north lighting and windows facing onto the courtyards. (The site uses north light to minimize heat gain in its tropical location.)
- Wind towers integrated with HVAC: The wind tower is a traditional passive cooling technique of the sub-continent. Here, it has been combined with the HVAC system to reduce energy consumption. The fresh air that goes in the Air Handling Unit (AHU) is pre-cooled in the wind tower, reducing the intake air temperature by three to five degrees Celsius. The wind tower itself is made of hollow masonry, and acts as a thermal mass. It is cooled periodically by trickling water from the top of the tower.
- Solar energy photovoltaic panels: Photovoltaic panels installed on part of the roof provide about 20 percent of total energy consumption, with the roof orientation and inclination designed to maximize the solar panels' efficiency.
- Roof garden insulation: A roof garden prevents formation of heat islands on the roof and acts as insulation, while providing an aesthetic benefit at the same time.

The features incorporated in the building drew high praise from the president of India as noteworthy steps towards energy efficiency, renewable energy and water management. The Platinum rating for this building has garnered attention, particularly in the construction industry, and generated considerable public awareness about green buildings in India.

Source: CII-Godrej Green Business Center and Confederation of Indian Industry.

Indonesia

The Plaza BII Building

Source: Eka Permana

The Plaza BII Building is located on the most prestigious boulevard in Jakarta, Jalan M.H. Thamrin. This 10-year-old building consists of a 39-story tower and a 3-story basement, with a gross floor area of 80,000 square meters. In 2005, the Plaza BII Building won the ASEAN Energy-Efficiency Award (Retrofit Category) because of the following energy-efficiency upgrading measures:

Energy-Efficiency Operational Discipline and Procedure

- Rescheduling and reduction of some essential electrical loads for equipment rooms.
- Eliminating some of the building's ornamental, vicinity and perimeter lighting.

Retrofitting

- Upgrading the building automation system by installing outside temperature sensors. The system can adjust the chilled water supply of the air handling unit based on the outdoor temperature.

- Modifying the power outlet circuit and integrating it with the operating schedule of floor lighting.
- Installation of door switches to all equipment rooms that switch off the room lighting when the door is closed.
- Opening up a part of the parking building wall to allow natural air and light into the area.

Tenants Participation in the Conservation of Energy

- Lighting is switched off during the noon-time break from 12:15 to 12:45 daily (Monday to Friday).
- Setting up a fixed room temperature of 25 degrees Celsius on one of the floors, at the request of the Japanese tenants who occupy that floor.

These measures enabled the building operator to achieve a 22 percent savings in electricity consumption and contributed to a rise in the occupancy rate from 84 percent before 2002 to 96 percent in 2006.

Source: Duta Pertiwi, "Energy Efficiency and Conservation: Best Practices of Plaza BII Building, Jakarta, Indonesia", see: http://www.aseanenergy.org/download/projects/promeec/2006-2007/building/vn/ID_Plaza%20Bii%20Indonesia%20Presentation.pdf

Japan

Osaka Municipal Central Gymnasium

The Osaka Municipal Central Gymnasium was built by the Osaka City Government in 1996. One of the unique features of the gymnasium is that the entire complex is built underground. Even the foundations of the two circular arenas are covered with earth, forming two hillocks, and the area appears to passersby to be an attractive green park. This design solution minimizes the cooling and heating load for the arena. The base and sides of the building are beneath street level, allowing geothermal heat to warm the building in the winter, while the earth's temperature ensures its coolness in summer. Other energy-saving measures adopted in this project include:

- Daylighting via membrane roof (skylights);
- Cooling/warming tube effect produced by underground concrete ducts;
- Arena lighting system capable of changing illuminating directions;
- Dynamic escape guiding system (buried-type guiding light);
- Air-conditioning during event only (cooling only; heating is not necessary);
- Temperature setting adjustment according to the size of the audience (for the arena, which is equipped with a Variable Air Volume system, adjustment of air temperature setting); and
- Natural ventilation on other occasions.

With these features, the gym is able to save 31 percent of annual electricity consumption compared with the building standard in Japan. This standard itself is already higher than other Asian economies.

Source: Global Environmental Center Foundation, Japan,
see: http://www.gec.jp/ESB_DATA/EN/building/html/esb-087.html

Itoman City Hall

Source: Hiroki Toyosaki

Itoman, a city on Japan's southern island of Okinawa, in 1996 announced its "Itoman City New Energy Vision," which called for all new public buildings to be equipped with sustainable energy sources. The Itoman City Hall, completed in 2002, is a public demonstration of the installation of a photovoltaic power generation system, with a capacity of 195.6 kW—the largest among Japanese local government buildings. The photovoltaic power generation system has the dual function of both producing electricity and, through its shading effect, reducing the need for air conditioning. The solar panels generate 12 percent of the energy requirements of the building; the panels on the roof and southern side of the building also act as sunshade louvers. They diffuse the strong sub-tropical sun of Okinawa, reducing the air conditioning load by 25 percent. In addition, a large semi-open space is created by staggering the photovoltaic louvers so they provide maximum shade and protection from wind and rain, while providing natural ventilation and daylight.

In addition to the photovoltaic power generation system, the building also implemented other energy-efficiency measures, including:

- A highly efficient heat source with thermal storage HVAC system;
- A natural air ventilation system; and
- An automated lighting system in the perimeter zone and high-efficiency, high-speed switching fluorescent lamps.

The building itself is a demonstration center showing the utilization of renewable energy in buildings. The power generated by the system and the CO_2 emissions avoided as a result are indicated in real time in the public gallery on the first floor of the city hall. Educational videos showing the importance of energy conservation and the possibilities for photovoltaic power generation, as well as the conservation efforts of Itoman, are also presented in the gallery.

Source: Kennichi Chikamiya, 2003, "BIPV Showcase: Itoman City Hall", Renewable Energy World, May-June; Atsuhito Oshima, Ministry of Land, Infrastructure and Transport, "Website of High-performance Buildings", Presentation for High-Performance Buildings and Developments project, Asia Pacific Partnership on Clean Development and Climate, see:http://www.asiapacificpartnership.org/BATF-HPBADUpdate.htm

Art Village Osaki Central Tower

Source: Ken Torii

The Art Village Osaki Central Tower was completed in December 2006 in Osaki, metropolitan Tokyo. It is a 22-story office tower with a total gross floor area of some 82,500 square meters. The building highlights some of the best green technologies available. The windows feature low-emissivity (low-e) double-glazed glass. The building's high-efficiency HVAC system reduces power consumption by using thermal storage systems, allowing for wide variation in temperature settings, controlling the quantity for volume and flow, and using natural ventilation. The lighting systems automatically adjust in tandem with the window blinds to maximize the use of natural light. Intelligent elevators regulate their voltage and frequency according to real-time demand. This building won the Excellent Building Mark issued by the Institution for Building Environment and Energy Conservation (IBEC).

Source: Dylan Robertson, 2006, "Environmentally Friendly Office Buildings in Tokyo", J@pan Inc, No. 68, see: http://www.japaninc.com/mgz_summer_2006_green_building

Malaysia

Low-Energy Office Building (LEO)

Source: Ministry of Energy, Water and Communications, Malaysia

The LEO building is the first government building in Malaysia to be built with integrated energy-efficient design. Located in the recently built government complex of Putrajaya, the LEO building was designed as a showcase building to demonstrate energy-efficient and cost-effective features in Malaysia. The building exceeded its targeted energy savings of more than 50 percent compared to buildings without energy-efficient design. An energy analysis based on consumption monitoring results revealed that actual energy savings reached 58 percent.

The building was finished and occupied in 2004. It is a 6-story office building with a total gross floor area of 38,600 square meters.

The building uses a wide variety of design elements and innovative technology. The approach to the building's use is integrated. For example, a comprehensive procurement system requires the purchase of energy-efficient appliances.

Building orientation and envelope:

- The windows are primarily orientated to the north and the south, with less direct sunshine.

- In addition to their optimum orientation, the windows are protected by appropriate shading mechanisms to allow for maximum light to penetrate while minimizing the transfer of heat. Towards the east, shading is deeper to protect against the low morning sun. The western façade has virtually no windows. The window glazing allows 65 per cent of the available daylight in while keeping 49 per cent of the heat out.
- The thick, light-colored walls of the LEO building reduce solar heating of the walls and insulate 2.5 times better than a traditional brick wall.
- The roof of the building is insulated with 100 mm of insulation, compared with the typical 25 mm of insulation. A second canopy roof also protects the roof surface, preventing direct solar radiation. Along the perimeter of the roof, green landscaping provides shade and improves the aesthetics of the roof areas.

Natural Air Ventilation:

- In the LEO building, the four-story high atrium provides daylight deep into the heart of the building. At the top of the atrium is a solar wall, or "thermal flue", which naturally cools the air by a few degrees.

Interior Space Layout Design:

- Permanent working areas are concentrated along the perimeter where there is maximum daylight. Secondary functions, such as storerooms and smaller meeting rooms, are relegated to the interior, where there is only artificial lighting.

Air Conditioning:

- Air conditioning in the LEO building has been made efficient in three ways. First, the air conditioning is not controlled from one central point. Instead, it can be switched off in individual rooms.

- Second, the air conditioning is set to keep occupied areas in the building at 25 degrees Celsius. Computer modeling shows that if the room temperature is 20 degrees Celsius, rather than 24 degrees Celsius, total electricity consumption of the building increases by one-third due to the higher cooling load.
- Third, Putrajaya as a whole receives chilled water from a district cooling plant, which operates on natural gas and which pumps cold water through underground pipes to all the buildings in the area, reducing the need for individual electric air-conditioning chillers in the different ministerial and commercial buildings.

Innovative Lighting System

The building uses high-efficiency light fixtures that automatically switch off when there is sufficient daylight. Additionally, a motion detector automatically switches off the lights and air conditioning in a room once no physical motion is detected.

Mechanical Ventilation

In the LEO building, air intake rises with higher CO_2 levels which in turn are affected by occupancy—the more people there are in the building, the higher the CO_2 as a result of breathing, and therefore the greater the intake of fresh air. A high-quality filtration system improves indoor air quality.

The LEO building was awarded the ASEAN Energy Award in 2006.

Source: Malaysian Ministry of Energy, Water and Communications, see: http://www.ktak.gov.my/leo/index.asp

Securities Commission Building

Source: H. Linho / Aga Khan Trust for Culture

The Securities Commission of Malaysia, the ASEAN Energy Awards (2001) Winner, is housed in an eight-story office building with a total gross floor area of about 94,000 square meters. Built in 1998, the building's sustainable features include:

Landscaping

Landscape features include water and greenery. A moat that runs around the building allows natural light to illuminate the rooms below. Other landscape features are an irrigation system, decorative lighting, soil moisture meters and localized shading structures.

Roofing System

Overhanging roof structures provide shading from direct sunlight. A deep roof insulates the building from the sun's heat and houses the building services plant room, atrium and main corridors. Acting as an internal courtyard, the atrium allows natural daylight to filter through the glass roof. Daylight is maximized and energy consumption is greatly reduced.

Facade and Shading Design

The double-skin façade, with horizontal and vertical shading devices within two glass layers, achieves a high level of transparency for daylight and minimizes the impact of solar heat and glare. A ventilated air gap walkway, automatic blind control, louvers, and air exhaust vent are also features that reduce the amount of heat the building absorbs.

Air Conditioners

The building has an efficient air-conditioning system. The air handling units are double-skin and variable-speed-drive-controlled. Variable air volume and terminals ensure optimum control of air conditioning. The under-floor discharge flows in the same direction as the thermal lift and thus consumes less energy to cool the building.

Lighting Systems

Automated solar blinds, which are directed by photo sensors, are connected to the Building Automation System (BAS).

Management and Maintenance Scheme

A high degree of control, management and automation is built into the building. In addition to computerized systems designed to maximize energy efficiency, skilled staff are on site during working hours.

Environmental Impact Consideration

No CFC or ozone depletion refrigerants are used. The low-emissivity glass on the façade is not highly reflective. The double-skin facade and roof plant room act as a climatic buffer and reduce noise pollution from the surrounding highways.

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_sector/energy_efficiency/energy_efficiency.htm

Zanariah Library of the Universiti Teknologi Malaysia (UTM)

The Sultanah Zanariah Library of the UTM is a 4-floor building with a total gross floor area of about 22,500 square meters. During the period 1993-1997, the University implemented an energy-efficiency retrofit, including a lighting retrofit, air handling units retrofit and chiller load reduction.

Lighting

The building uses white light lamps with electronic ballasts and high-efficiency reflectors. The light level of the library was reduced where it was found to be too high.

Air Handling Unit

Work undertaken to reduce the flow rates and increase the efficiency of the HVAC system included:

- Replacing an old oversized motor with a new efficient one;
- Replacing an old oversized fan and motor pulleys with optimally designed ones;
- Aligning pulleys to reduce transmission losses;
- Electrical connection to motor and adjustment of over-load relay setting; and
- Control and monitoring.

After the retrofit, total savings amounted to 36.5 percent of the original load. The retrofit also improved the comfort level for users of the library. In 2001, this project was runner-up for an ASEAN Energy Award (Retrofitted Buildings).

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_sector/energy_efficiency/energy_efficiency.htm

Philippines

Makati Stock Exchange Building

Source: Ayala Corp.

The Makati Stock Exchange Building is an eight-story office building with a total leasable area of around 30,000 square meters. Owned by the Ayala Corporation, the building was built in 1971 and formerly served as the headquarters of both Ayala Corporation and Ayala Land, as well as of the Makati Stock Exchange.

Because the building was 25 years old when the retrofit began, upgrading its energy efficiency was a challenge. In addition, the 24-hour-a-day, seven-days-a-week operations of the building's largest tenant, Accenture, meant that any retrofitting work would have to be done in a low-impact manner. From 1996-2005, the building went through continuous energy-efficient improvements, including equipment upgrades, introducing new technologies and implementing energy-saving projects. Savings generated by these improvements total around US$127,000 (or 941,000 kWh) per year. The building retrofit included the following measures.

Air Conditioning

- Replacement of the chiller units with more efficient ones.
- Installation of a condenser cleaning system. The system keeps chiller condenser tubes clean and thus increases efficiency.
- Replacement of cooling coils of all the Air Handling Units. This restored the cooling efficiency of the Air Handling Units to their designed efficiency.
- Installation of high-efficiency Air Handling Unit motors. To improve the efficiency of the Air Handling Units, all motors were replaced with high-efficiency units.
- Installation of Variable Frequency Drives (VFDs). VFDs were introduced in all condenser and chilled water pumps to improve efficiency.

Lifts

- All elevator units of the building were replaced with more efficient units.

Lighting

- Installation of energy-saving equipment for the lighting system. Voltage controllers for fluorescent lighting units were installed to help cut the electrical consumption of the common area lighting by reducing the input voltage once the lamps are turned on.
- De-lamping of parking level lighting. All parking levels with 2x40-watt fluorescent lamp fixtures were replaced with 1x40-watt fluorescent lamps and mirrorized reflectors. Individual switches were also provided so lights can easily be turned off at night time.

- Re-lamping of basement parking. The existing rapid-start ballasts were replaced with electronic ballasts.
- De-lamping of hallway lighting. The existing 4x40-watt lighting was reduced to 2x40-watt lighting.
- Re-lamping of fire exit stairs. The existing 50-watt incandescent bulbs used to light the fire exit stairs were converted to fixtures using 11-watt compact fluorescent lamps (CFLs).
- Calibration of kWh meter. All electric meters in both the tenant spaces and common area were calibrated.

Recently the building management system was also upgraded to effectively control and monitor the centralized air-conditioning system and ventilation equipment of the building. The building administration and staff have established an Energy Conservation Management Team to manage the schedule of all operating equipment within the building. In 2006, the building received the ASEAN Energy-Efficiency Award (Retrofit Category) (2nd Runner-Up).

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org and e-mail communication from the Office of the CEO, Ayala Corp., August 2007.

Singapore

Headquarters of Urban Redevelopment Authority


Source: Sengkang on Wikimedia Commons

The Urban Redevelopment Authority (URA) Centre, a runner-up for the 2001 ASEAN Energy Award, is the headquarters of the Urban Redevelopment Authority of Singapore. Built in 1999, the building has a 5-story podium and a 16-story office tower, with a total gross floor area of around 38,000 square meters. The podium and tower is connected by a 5-story glass atrium, which functions as an amenity centre. Energy-efficiency features of the building include:

- Integrated Building Design: As noted throughout this study, the most energy-efficient buildings start with integrated design. In this case, the building envelope includes low-emissivity (low-e) double glazed, light green glass windows. These reduce solar radiation and transmission without compromising visibility. The building's granite cladding exterior provides good insulation, while horizontal louvers, vertical fins and aluminum sunshades provide shade and reduce heat.
- Highly Efficient Mechanical & Electrical (M&E) Equipment: The lighting system uses highly efficient fluorescent lighting, which includes dimmable electronic ballasts. Motion detectors cut down

energy waste by shutting down systems when no one is present. The air-conditioning system is flexible. Variable speed drives regulate the supply of air flow of the air handling unit in accordance with load changes in order to save energy.

- Advanced elevator system: The building's elevator control system allows the passenger to select the desired floor at the lift lobby. Such a system provides fewer stoppages, shorter average waiting time and faster turn-around, thus lowering energy consumption.
- Management and Maintenance Scheme: An integrated Building Automation System (BAS) monitors and logs energy use and searches for trends. A work improvement team conceptualizes and implements energy-saving projects. A comprehensive computer-aided facility management system pre-determines and tracks all the required maintenance work. Staff members each receive 100 hours of training to ensure that they keep pace with the latest facility management knowledge and skills.

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_sector/energy_efficiency/energy_efficiency.htm

The Tresor

Source: Keppel Land

Keppel Land, a unit of the Keppel Group, has been incorporating systems that enhance energy efficiency in its residential projects. Environmental protection features that ameliorate the greenhouse effect, ozone depletion and depletion of energy resources have become important standard features in its building designs. One example of Keppel's commitment to energy-efficient building design is The Tresor, a residential complex in the Bukit Timah area that consists of two 5-story building blocks with a total floor area of about 110,000 square feet (around 10,200 square meters).

At The Tresor, the facade of the buildings is oriented to the north and south to minimize heat from the sun. The building has an energy-saving envelope that includes energy-conserving double-glazed low-emissivity glass that reduces cooling load, as well as energy-saving lighting, lift and air-conditioning system. Carbon monoxide sensors added to the car park exhaust fans allow fans to be automatically switched off whenever the carbon monoxide concentration is at safe levels. The cost for these sensors is around SGD$10,000 (around US$6,600), but about SGD$15,000 (around US$10,000) of energy cost be saved per year because of the sensors.

Other environmentally friendly design features include those for water efficiency, indoor environmental quality and outdoor environmental protection, such as adoption of solar-powered lights, electrical and water sub-metering and conservation of existing plants and trees. Care was also taken to minimize environmental impact during construction, such as noise, water and air pollution.

It is estimated that the project will save about SGD$36,000 (around US$ 24,000) per year in electricity costs. In 2006, The Tresor received the Green Mark Gold Award 2006 from the Building and Construction Authority in Singapore.

Source: E-mail interview with Lee Kia Young, Project Manager of The Tresor, Keppel Land, July 2007.

Keppel Bay Tower

Source: Keppel Land

Given rising energy prices, environmental degradation and improved managerial oversight, members of the Asia Business Council are interested in enhancing competitiveness of their companies through enhanced energy efficiency. Beginning in 2005 and continuing into 2006, the Council developed a program to assist member companies to improve energy efficiency by providing a free initial energy audit. In the program, the Council contracted with an energy service company and performed initial energy audits for 6 building or industrial facility projects for member companies in 2006, including the Keppel Bay Tower, a commercial office building also developed by the Keppel Group.

Located at Singapore's new waterfront business hub, Keppel Bay Tower is one of the twin towers of the HarbourFront Office Park and was finished and occupied in November 2002. This 18-story office building has a total lettable area of 394,745 square feet (around 36,680 square meters).

The energy audit highlighted several areas for increased energy efficiency and made recommendations for improvements. Based on the findings of the audit, Keppel has been implementing the proposed efficiency upgrading measures since early 2007. As of July 2007, all proposed equipment and systems had been installed and were being fine-tuned. Systematic monitoring of savings will start in August 2007. Measures implemented include:

Optimization of chiller performance

Tuning of refrigerant pressure to ensure that chillers operate at optimum level.

Re-configuration of chilled water pumping strategy

Variable speed drives (VSD) for pumps and differential pressure sensors were installed to regulate the chilled water circulation.

Optimization of cooling towers operations

Variable speed drives were installed at cooling tower fans to regulate fan speed to achieve optimum condenser water temperature.

Demand-controlled car park ventilation system

Carbon monoxide and temperature sensors were installed at various locations in the car park.

Installation of S-Optimizer

This is an intelligent monitoring and control system for the items above. Additional temperature sensors and water flow sensors were installed at various locations in the systems. Power transducers were also used to monitor the electricity consumption of each piece of equipment.

Fine-tuning of the air handling unit

Site readings (temperature, pressure, airflow, humidity, etc.) were taken with calibrated instruments and compared with existing sensors. Inaccurate sensors were replaced and set points re-adjusted.

Reduction in car park lighting consumption

Twin-tube conventional light fittings were replaced with single high-efficiency lamp fittings using electronic ballasts. Reflectors were also fixed onto the fittings to maintain brightness.

The total cost of these measures was around SGD$300,000 (around US$200,000), with targeted savings of 14 percent in electricity consumption, or SGD$136,000 (around US$90,000) per year. The payback period is around 2.2 years.

Source: E-mail interview with Lim Tow Fok, General Manager, Property Management, Keppel Land International Limited, July 2007.

South Korea

The Kolon R&D Institute of Technology Building

Source: Kolon Group

The office building of the Kolon R & D Institute of Technology was completed in October 2004 in Yongin-Si, Gyeonggi-Do, Korea. Energy-efficient features of the building reduced its energy costs by more than 50 percent, compared to a typical building, and the building was awarded the top grade in the Korean system of green building certification.

The design maximized the efficiency of daylighting and natural ventilation.

Natural Ventilation

The building was designed to maximize the positive characteristics of the construction site. The siting of the building allows the prevailing wind to pass between the north and south sides of the institute. A central atrium creates an upward draft for additional ventilation.

Solar Tube System

A solar tube system, which effectively pipes light into the interior of the building and is twice as cost-effective as alternatives, was installed on the third floor of the building—the first case in Korea to utilize such an indirect daylighting device.

Energy-Efficient Envelope Design

The environment-friendly, energy-saving envelope design of the building is the first of its kind in Korea. It has two layers, or a double skin, which dramatically increases its insulating properties. A study showed that the average temperature differential between areas with and without the double skin exceeded 3 degrees Celsius. The company also developed a number of installation procedures that resulted in a 75 percent cost savings compared to existing double-skin installations.

Geothermal Heat-Pump System

Despite Korea's harsh climate, the institute uses a geothermal heat-pump system as its only means of temperature control. Since completion of the building, system efficiency has been continuously monitored and the result is better than anticipated. A heat exchanger, developed with in-house technology, contributes to building temperature control. The system enables a 60 percent reduction in building maintenance costs compared to similar-sized buildings, is easy to operate, and provides a pleasant environment.

Photovoltaic System

An experimental photovoltaic system, one that Kolon calls the BIPV (Building Integrated Photovoltaic) scheme, functions as both an exterior structure and an electricity generator. Forty-five square meters of glass-type solar cells have been installed on a southeast-facing vertical wall. The system produces 6 kW, which is enough electricity to light 120 fluorescent bulbs, so it has great potential for use as a building exterior finishing material. Kolon Engineering & Construction plans to distribute the system after further performance verification.

Rooftop Landscape and Biotope

Ordinary rooftop landscapes with shrubs planted in 80 cm of soil often create overweight situations that require larger frames, making them expensive to build and difficult to manage. Kolon R & D Institute of Technology's rooftop landscape uses only 20cm of soil and hardy, easy-to-care-for ground cover plants. This landscape not only provides a recreation space with a small eco-system, but also insulates the building to reduce cooling and heating energy requirements.

Source: Seong-jin Lee, 2006, "The Kolon R & D Institute of Technology", International Initiative for a Sustainable Built Environment, Advanced Building News 09, see: http://iisbe.org/ABNnews/ABN_09.pdf

Taiwan

Taipei Metro

Source: Far Eastern Group

The Taipei Metro complex, Taiwan's first hybrid development project, was developed by the Far Eastern Group. This complex consists of two 41-story twin towers and a 5-story basement, accommodating the group's headquarters, a five-star hotel and a shopping mall. Taipei Metro has incorporated a series of energy-efficiency measures in its building design, although this complex has never pursued any certification for its high energy performance. Its energy-efficiency features include:

Ice-Thermal Storage HVAC System

The building has an ice-thermal storage HVAC system that provides the flexibility to make ice in large silver tanks in the late night, when electricity demands are low and rates are much cheaper. The ice is melted during the day to cool the air. This system reduces peak demand, shifts energy usage to non-peak hours, saves energy, reduces energy costs, and reduce CO_2 emissions. Benefits of the system include:

- Installation at the same or lower first cost than traditional systems because of the use of smaller chillers and cooling towers, reduced pump and pipe sizes and less horsepower. These offset the cost of the ice thermal storage equipment.
- Lower peak electrical demand for the HVAC or process-cooling system by 50 percent or more, thus reducing strain on electrical grids.
- Substantial savings, as the charge for power during non-peak hours is lower during peak hours. In Taiwan, electricity charges during peak daytime are 3.4 times those during the night. Moreover, ice storage HVAC systems enjoy an extra 25 percent off regular rates in Taipei.
- Reduced greenhouse gas emissions. Electricity generated at night generally has a lower heat rate (lower fuel use per power output), and therefore lower greenhouse gas emissions. The California Energy Commission concluded that nighttime electricity production resulted in a 31 percent reduction in CO_2 emissions compared with daytime production.[74]

In the Taipei Metro, the total cost for the ice-thermal storage HVAC system was around TWD$100 million (more than US$3 million), while annual savings in electricity bill is around TWD$12 million (around US$365,000), with a payback period of less than 8.5 years.

Double-Glazed Curtain Wall

An energy-efficient, double-glazed curtain wall was installed for better heat and sound insulation. Energy savings because of the curtain were around 2-3 percent of total consumption, or around TWD$2-3 million (around US$61,000-91,000) per year.

Honeywell Auto-Control Monitor System

This auto-control system integrates and centralizes the various building systems (for example, the power supply system, plumbing system, emergency generator and uninterruptible power supply system, HVAC system, lighting system, fire alarm and smoke exhaust system). The system is designed to optimize energy performance of the building. The cost for the auto-control system in Taipei Metro was around TWD$200 million (more than US$6 million), while the improved efficiency led to a reduction of 3-5 percent in annual energy consumption, or TWD$3-5 million (more than US$91,000-152,000) in the electricity bill per year.

Auto-Frequency Converters

Auto-frequency converters are used for converting power frequency, voltage and phase according to actual loading in order to avoid overloading power wastage. In Taipei Metro, the investment for converters amounted to around TWD$9 million (around US$274,000), while annual savings achieved were around 10-15 percent of total energy consumption, or around TWD$1.1-1.35 million (around US$33,000-41,000) per year.

High-Efficiency Lighting System

Fluorescent ballasts and light emitting diodes (LED) were used in the building.

Auto-Power Factor Correction Equipment

The building installed auto-power factor correction equipment to stabilize power factor to achieve higher efficiency. The costs for the equipment was around TWD$5 million (around US$152,000), and annual savings achieved was around TWD$300,000 (more than US$9,000).

These energy-efficiency measures have enabled Taipei Metro to achieve savings of around TWD$ 20 million (around US$ 610,000) in energy bills every year.

Source: E-mail interview with the Office of the Chairman, Far Eastern Group, July 2007.

Delta Electronics Complex

The Delta Electronics Complex was the first building in Taiwan to pass all nine benchmarks of the EEWH (ecology, environment, waste reduction, and health) system, the official green building rating system of Taiwan's Ministry of Interior. It received Taiwan's first "gold-rated" Green Building Certificate and was awarded "2006 Green Building of the Year" by the Ministry of Interior.

Situated on 1.89 hectares of land in the Tainan Science Park, the 12,800 square-meter building accommodates around 300 staff. It is built entirely using green building methods, and is intended for R&D, manufacturing and general office space—a mixed office-factory building.

The energy-efficient design of the building begins with its building envelope. The building's recessed openings are shaded to reduce direct solar heat gain, while the solar panels on the roof provide both an energy source and insulation. A roof garden also helps reduce heat gain. Inside the building, a well-ventilated high-ceilinged atrium provides both light and a refreshing effect. In the underground car park area, light wells on two sides allow sunshine to reach down and illuminate the otherwise dark space. Energy-saving lighting devices and high-efficiency HVAC systems are also used.

According to Delta, this building achieves up to 31 percent in energy savings, compared with average office buildings in Taiwan. Other benefits include an improved working environment for staff and enhanced corporate image.

Sources: Website of Delta Electronics Inc., see: http://www.deltaww.com/; Oscar Chung, "Greening the Gables", Taiwan Review, May 01 2007, see: http://taiwanreview.nat.gov.tw/

Beitou Library

Source: KaurJmeb on Wikimedia Commons

The Beitou Library is a two-story 1,990 square meter structure largely made of timber. It is a branch of the Taipei Public Library, and was formally opened to the public in November 2006.

The building incorporates a passive design approach to maximize daylighting and natural ventilation. Large French windows help cut electricity usage in two ways. An abundance of natural light for the interior means less lighting is required. The windows can be opened to provide ventilation, reducing the need for fans and air-conditioning.

One part of the roof is covered by photovoltaic cells that are expected to convert sunlight into at least US$1,000 worth of electricity per year. Another part is covered by plants and shrubs to provide thermal insulation. During Taipei's chilly winters, the garden cuts heat loss through the ceiling and thereby makes the interior more comfortable. In the summertime, the foliage blocks some of the heat of the sun.

Source: Steven Crook, "Green Buildings Paint Bright Future", Taiwan Journal, Vol. XXIV, No. 24, June 15 2007.

Thailand

Mike Shopping Mall

Mike Shopping Mall is the largest shopping mall in Pattaya, Thailand. It has nine floors and a basement, with a total gross floor area of around 42,000 square meters. It is a multi-function complex consisting of a department store, a shopping plaza and an office. Oriented towards a beach, the mall is a favorite shopping destination of both Thai and non-Thai tourists.

In 1996, Mike Shopping Mall was designated for an energy retrofit under the Energy Conservation and Promotion Act of Thailand. The Thai government provided technical guidance and financial assistance to complete the retrofit.

An energy service company (ESCO) conducted an energy audit for the mall. To eliminate the risks on investment, the services of the ESCO were engaged to deliver a level of guaranteed savings without compromising the building's design and comfort. If the projected savings fall short of a guaranteed amount, the ESCO pays the difference.

More than 20 energy-retrofitting measures have been implemented using both passive and active concepts. They range from no cost to low-cost to easy-to-do measures. An energy audit is conducted every six months to highlight further efficiency improvements.

The retrofit turned out to be successful. Energy savings are about 31 percent annually and investments were paid back in 1.3 years. The project also pioneered the promotion of a performance guarantee business concept between an ASEAN building owner and an ESCO. The concept is critical in convincing building owners to undertake an energy retrofit for a project that requires a significant amount of investment. The building won the ASEAN Energy Award for Retrofitted Buildings in 2001.

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_sector/energy_efficiency/energy_efficiency.htm

PART III – BUILDING ENERGY EFFICIENCY POLICIES IN ASIA

China

Summary

- China has been transformed from an energy exporter as recently as the early 1990s to the world's third-largest net importer of oil in 2006. The growth rate of its energy consumption through 2030 is predicted to be the highest in the world.
- Nearly half of the world's new building construction now is in China—this will also be the case for the next 10 years. Energy consumption of buildings rose from 10 percent of the total in the late 1970s to more than 25 percent in 2006, and is expected to soar to 35 percent soon.
- There has been a distinct shift in China's national energy policy from a previous focus solely on energy development to emphasis on both development and efficiency; building and transport sectors are accorded the same importance in the energy conservation policy as the industry sector.
- Although China's building energy-efficiency program remains focused on the enforcement of building energy codes, recent efforts go beyond that through demonstration buildings, building performance ratings, and green building rating systems. These initiatives remain exploratory, but public concern about the environment, energy waste, and climate change has grown rapidly in

recent years, and may lead to major changes in China's booming construction industry.

- Cities across China enforce building energy standards to varying degrees. Enforcement infrastructure is, to a certain degree, established in major cities, e.g., Shanghai, Beijing, Guangzhou, Shenzhen, Tianjin and Wuhan, with rising compliance rates. But enforcement is still spotty in the smaller cities and towns.

Data Profile

China was largely self-sufficient in energy before the 1980s. The first two oil shocks in the 1970s had little impact on the Chinese economy and energy sector. Indeed, China exported crude oil to several of its Asian neighbors during this period.

Since the early 1980s, with the nation's industrialization and urbanization drive, domestic energy production has failed to keep pace with China's growing energy demand. In 1993, China became a net importer of oil and in 2006 it became the world's third-largest net importer of oil, behind the U.S. and Japan.

The large gap between stagnant energy production and fast-growing consumption is projected to expand further in the next two decades. According to the Energy Information Administration (EIA), China's oil and natural gas consumption is projected to rise 3.8 percent and 6.8 percent annually, respectively, through 2030. Both are the highest in the world. With such a growth rate, China's energy demand is likely to more than double in two decades from the current level.

Such rapid growth in energy consumption is attributed to a rapid rise in demand in China's energy-intensive industries, as well as its building and transport sectors. The building sector, which accounted for 10 percent of total national energy consumption in the late 1970s, consumed more than 25 percent of the total over recent years and is forecast to soar to 35 percent within the coming 10 years.[75] Approximately 2 billion square meters of floor area are being constructed annually, which accounts for almost half of the annual constructed floor area worldwide.[76] Existing buildings in China amount to some 40 billion square meters,[77] and this number is expected to double by 2020. According to experts, 95 percent of China's buildings are "highly inefficient," with envelope thermal conditions that are two to three times less efficient than those in developed countries.[78]

Undoubtedly, the energy performance of so much new construction, as well as that of the huge stock of existing buildings, will have significant repercussions on global energy consumption and greenhouse gas emissions.

National Energy Policy

Alarmed by China's rapid growth in energy consumption, government officials have started to worry that energy shortages and increasing imports would become a bottleneck hindering economic growth, threatening both the environment and national security. In 2004, the State Council's Development Research Center published a report exploring options for a national energy strategy: China National Energy Strategy and Policy 2020 (NESP). According to the report, China spends 13 percent of its GDP on energy, almost double the level in the U.S. The report also said that China could decrease its use of energy from predicted levels by 25 percent by 2020, if it were to take effective energy-saving measures. The Chinese government has begun to recognize that the country has great potential to improve efficiency and alleviate the impact of shortages in energy supply.

This backdrop has induced a significant shift in China's energy policy in recent years. Although the Chinese government has been pushing energy efficiency and conservation since the late 1980s and has achieved significant accomplishment, energy development was seen as the main strategy for securing long-term economic development and national security. In recent years, however, improving energy efficiency has been assigned a high priority, with equal importance as energy development.

In 2004, the State Council approved an energy development program for 2004-2020. It is China's first long-term energy policy in almost half a century. The program lists energy conservation as its first concern, along with other principles such as optimization of the energy consumption mix, promotion of environmental protection, and protection of energy security. This stated new philosophy represents a shift from a previous sole focus on energy exploitation. Central leaders have reached consensus that it will not be sustainable to rely on heavy energy consumption to drive the economy.

In the latest national development plan, the 11th Five-Year Plan (2006-2010), it is stressed that China will develop a resource-efficient development mode with Chinese characteristics by giving priority to resources and energy savings, and promoting a recycling economy to gradually create savings-oriented industrial and consumption structures.

Energy-Efficiency Policies

There has also been a notable change in China's energy-efficiency policy. Energy efficiency in the industrial sector, which was the single biggest energy consumer in China in the past decades, had been the sole priority. In recent years, with the significant increase of energy consumption in building and transport, these two sectors have been accorded the same importance as the industry sector.

In November 2004, the National Development and Reform Commission (NDRC) unveiled the China Medium and Long Term Energy Conservation Plan (Conservation Plan), which stresses that energy conservation is a long-term strategic guideline in China's economic and social development and an extremely urgent matter at present. The plan established two main principles: 1) China should adopt neo-industrialization, in which energy-savings play an important role,[79] and 2) the market is expected to play the leading role in allocating resources.[80]

According to the Conservation Plan, over the medium term period China is focusing energy savings in four equally important areas: the industrial sector, transportation, construction, and commercial and civil power use.

Building Energy-Efficiency Policies and Initiatives

Building Energy-Savings Targets

China began to pay attention to building energy-efficiency issues in the mid-1980s when large-scale urban construction (mainly residential buildings) began. Since early 2004, building energy efficiency has been emphasized to an unprecedented degree, with ambitious energy-saving targets being set in the Conservation Plan:

> *By the end of 2010, all Chinese cities will be expected to reduce their buildings' energy use by 50 percent; by 2020, that figure will be 65 percent. Furthermore, by 2010, 25 percent of existing residential and public buildings in the country's large cities will be retrofitted to be greener; that number will be 15 percent in medium-sized cities and 10 percent in small cities. Over 80 million square meters of building space will be powered using solar and other renewable energies.*[81]

For the Eleventh Five-Year Plan (2006-2010), ten programs have been planned for improving energy efficiency. Building energy efficiency is one of them and there are two others related to buildings (the Environmentally-Friendly Lighting Program and the Program of Energy Conservation in Governmental Departments). The building sector is expected to contribute 40 percent of the total energy-saving target for the Eleventh Five-Year Plan period. The main strategies for achieving the target include strictly enforcing the standards of energy-efficiency design for construction industries and improved appliance/equipment efficiency for commercial and civil energy conservation.[82]

Building Energy-Efficiency Standards

Evolution

At present, there are two sets of national building energy standards in China, one for public, or non-residential, buildings and another for residential buildings. These national standards are model energy standards, roughly analogous to the International Energy Code (IEC) or ASHRAE 90.1 in the United States, with their actual enforcement relegated to the local governments or construction commissions. In a number of instances, individual cities and provinces have developed their own standards, either before the national standard became available, or if the local standard was more stringent.[83] However, by and large the recent efforts in developing national building energy standards have made most of the local standards outdated and unnecessary.

China's Ministry of Construction (MOC) issued the first energy design standard for residential buildings in the Heating Zone in north China in 1986, and revised it in 1995. The energy-saving target of this standard was a 30 percent reduction in heating energy use, compared with pre-existing buildings, by 1986, and a 50 percent reduction by 1995. In 2001, a standard for residential buildings in the Hot-Summer Cold-Winter Region in central China was issued, followed by a standard for the Hot-Summer Warm-Winter Region in south China in 2003. The energy-saving target was set at a 50 percent reduction in total heating and cooling energy use. A revised national energy design standard for residential buildings that combines the three previous regional standards has been under development since 2005, and is expected to be completed in 2007. Preceding these national or regional standards, there have also been local standards in major cities, such as Beijing, Tianjin, Shanghai, and Chongqing.

For non-residential buildings, the first energy standard was the standard for tourist hotels adopted in 1993, targeting 30 percent energy savings compared to pre-existing buildings. In 2004, a national energy-efficient design standard for public buildings (similar to commercial buildings) was adopted. This is China's first such national standard, although Shanghai had produced a local standard for commercial buildings in 2003. This standard set a target of 50 percent energy savings in heating, cooling and lighting energy use compared to pre-existing buildings, achieved through improvements to the building envelope, HVAC, and the lighting system.[84] The savings from envelope and equipment measures varies by climate, with envelope savings ranging from 13-25 percent, HVAC, 16-20 percent, and lighting, 7-18 percent.

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One characteristic shared by all of China's building energy standards is their narrow scope. The residential standards are largely envelope standards; the public building standard also addresses HVAC system efficiency, but not that of the lighting, electric power, or hot water systems. One reason for this is that the MOC has separate energy standards for lighting (Building Lighting Design Standard GB 50034-2004), room air conditioners, and commercial HVAC equipment, to which the building standards refer. Another reason is that in residential buildings, air conditioning is installed by the apartment owner, making any requirements in the building standard difficult to enforce and thus largely advisory.

The residential standard contains prescriptive requirements for the roof, floor, wall, and windows that vary by climate and the number of floors of the building. The window requirements vary by the window-to-wall ratio, with more stringent thermal requirements (in the heating-dominant climates) or shading coefficient (in the cooling-dominant climates) requirements for larger window areas. Compared to the residential standard, the prescriptive envelope requirements in the public building energy standard have similar to somewhat lower thermal requirements for both opaque surfaces and fenestration, but noticeably more stringent shading coefficient requirements in recognition of the higher cooling loads in public buildings.

In addition to these prescriptive requirements, both the new residential and public building standards contain performance options whereby a building is deemed to meet the standard so long as its calculated building energy use is below that of a reference building. This "custom budget" approach is similar to that used in U.S. standards such as ASHRAE 90.1, and differs from the "fixed budget" approach found in several other Asian countries.

Both standards have a chapter on the requirements for equipment.[85] In addition, the public building energy standard also has a chapter on monitoring and controls, mostly with recommendations on how to control the building HVAC system for energy efficiency, and enabling the possibility of energy monitoring. The standard does not cover lighting systems, a very important aspect of energy efficiency in large buildings, which is covered in a separate lighting energy standard that was developed by the MOC in 2003.

Jurisdiction

From an institutional point of view, China has the benefit of a centralized ministry (MOC) responsible for regulating a building industry that over the past decade has built roughly half of the new construction of the entire world. Under the MOC, there is a network of construction commissions in the major cities and provinces to oversee building construction, including the granting of building permits and enforcement of building codes, as well as a parallel network of building research institutes to provide technical expertise and support to the MOC and the building industry. Within the MOC, building energy standards fall under the jurisdiction of the Department of Standards and Norms. However, the technical development of building energy standards is the responsibility of the Department of Science and Technology, in collaboration with building research institutes, universities, and industry representatives. For example, for the current residential and public building standards, compilation committees were organized under the leadership of the China Academy of Building Research.

Implementation

As in many other countries, the point of control in enforcing building energy standards is during design and construction, with non-compliance resulting in the building permits not being issued. Although the MOC has made both standards mandatory, enforcement remains a problem, especially in small and medium-sized cities. A survey conducted by the MOC in 2005 of code enforcement in northern China identified another problem: while over 87.5 percent of the buildings complied with the energy standard on paper, less than 49 percent were found to be compliant upon actual inspection. Barriers to effective enforcement include the lack of supporting information, training, resources and political will in supporting the enforcement of the code.

Appliance/Equipment Labeling and Standards

Since 1989, China has developed one of the most comprehensive appliance standards and labeling programs in the developing world.[86] The program includes mandatory minimum energy-efficiency standards, voluntary endorsement labeling, and mandatory energy-information labeling: [87]

- The minimum energy-efficiency standards are mandatory and have been issued for 23 types of appliances and equipment.
- The voluntary endorsement label has been issued for 36 types of appliances, lighting, and industrial products.
- The information label is currently under development.

In fact, in terms of the coverage of the labeling and standards program, China is the leader whose program covers the most types of appliance/equipment among the 11 Asian economies reviewed in this study. However, the program lacks effective implementation and enforcement due to the lack of transparency in the standards-making process, a lack of monitoring and penalty measures, etc.[88]

Other Initiatives

Although the MOC continues to regard the enforcement of building energy standards as the linchpin in improving building energy efficiency, there have also been a number of pilot efforts or discussions about voluntary market-based programs.

Green Building Movement

To encourage buildings to go beyond the minimum energy-efficiency requirement, the MOC recently unveiled the "Evaluation Standard for Green Building" (GB/T 50378-2006), which took effect June 1, 2006. The standard is similar to that of LEED. MOC will collect building energy consumption data, assess energy performance based on the standard, and issue the three-star Green Building certification to qualified buildings. The local government will be in charge of the issuing of lower level one-star and two-star certifications.[89]

In support for a Green Olympics for the 2008 Games, the Beijing Science and Technology Commission sponsored the development of another green building rating system, Green Olympic Building Assessment System (GOBAS), led by Tsinghua University. The system is modeled primarily on Japan's Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) and, to a lesser extent, on LEED.

Since these two national green building rating systems came into being just recently and are still in the early stages of development, high-performance building projects sponsored by both government and business are seeking recognition for their energy performance with international green building systems like LEED. Up to the end of 2006, 5 projects from China were certified under LEED (see Part II for the first LEED-certified commercial project in China, the TaiGe Service Apartments).

Building Inspection Program

In 2005, the central government began a nationwide building inspection program to monitor the implementation of energy-efficiency regulations. Design institutions, developers, and construction companies that do not comply with regulations can lose their license or certification. A CNY500,000 (around US$66,000) fine was recently introduced for new buildings that are found not to have met the standards. Retrofit of the building will be required after the fine.

Demonstration Cities and Projects

To promote the implementation of national policy at the local level, seven cities (Shanghai, Beijing, Shenzhen, Chongqing, Fuzhou, Xiamen and Tianjin) have been chosen as pilot cities by the central government to develop local building energy-management systems, with the help of international organizations like the Chinese Sustainable Energy Program (CSEP), to showcase energy-efficient technologies and practices.[90] Initiatives include establishing the design examination system of energy efficiency in buildings, formulating local building codes, instituting an energy-efficient building rating and certification system, training architects and engineers, and promoting the development of an energy-efficient materials and products market.

Meanwhile, there have also been numerous demonstration buildings showcasing energy-efficient technologies and practices in Beijing (e.g. the new headquarters building of the Ministry of Science and Technology in China 2004, Tsinghua Sino-Italian Ecological and Energy-efficient Building 2005, Low-energy Demo Building 2005), Shanghai (Shanghai Research Institute of Building Sciences Eco office 2006), and other cities.

Planned Energy Consumption Data Collection

China is planning to establish energy consumption data collection and energy audit and information disclosure mechanisms for government office buildings in the 11th Five-Year Plan period (2006-2010). These measures are expected to enable consumers to make informed decisions, and promote the taking up of energy-efficiency measures by developers.

Planned Financial Incentives

Until now, China has offered no financial incentives through its national policies to promote energy-efficient buildings. However, MOC has conducted extensive studies on the introduction of an incentive mechanism and produced a first draft, which will soon be submitted to the State Council for examination and approval. Meanwhile, the Regional Finance Research Division of the Research Institute for Fiscal Science (under the Ministry of Finance) and the China National Institute of Standardization are designing tax and fiscal policies to encourage commercialization of efficient appliances and equipment. They are expected to develop policy recommendations and an implementation plan. At the local level, certain progressive cities such as Shenzhen are beginning to offer financial incentives to developers who use energy-efficient building technologies.[91]

Hong Kong

Summary

- The building sector accounts for more than 50 percent of total final energy consumption in Hong Kong; and this amount is rising as energy consumption in the building sector grows faster than in other sectors.
- Public awareness of environmental protection is developing in Hong Kong as people suffer from severe air pollution. Government and the public view energy efficiency as one of the key measures to address this problem.
- The Hong Kong government is taking a voluntary and lead-by-example approach to improving building energy efficiency. A variety of building energy-efficiency measures and programs are available on voluntary basis, while substantial efficiency improvements are being undertaken in government buildings in order to provide a role model and showcase energy-efficiency technologies and practices for the private sector.
- Hong Kong is one of only two economies among those reviewed in this study that have non-government building energy-efficiency programs. The Building Environmental Assessment Method (BEAM), a voluntary green building rating and certification system, is the most widely used green building scheme in Asia, and has been adopted in over 100 premises.

Data Profile[92]

Hong Kong derives its energy supplies entirely from external sources. Between 1995 and 2005, the final energy consumption in Hong Kong increased by 14.0 percent, with an average annual growth rate of 1.3

percent, while GDP grew at an average annual rate of 3.9 percent in real terms over the same period.

Unlike other Asian countries where the industrial sector accounts for 30 to 50 percent of total energy consumption, Hong Kong, as a service-based economy, has a shrinking industrial sector. Its proportion of total final energy consumption decreased from 20 percent in 1994 to 10 percent in 2004. The building sector is Hong Kong's biggest energy consumer, with total final energy consumption rising from 44 percent in 1994 to 54 percent in 2004. As the second largest consumer of energy, the transport sector accounted for 35 to 38 percent during the same period.

The building sector is also the largest user of electricity and gas, taking up around 90 percent and 97 percent of the total local consumption of electricity and gas, respectively.

Air conditioning accounts for more than 30 percent of the total electricity consumption in Hong Kong. Non-domestic buildings consume 72 percent of air conditioning. Hong Kong's total electricity consumption grew by 52 percent from 1990 to 2000, while the electricity consumption by air conditioning grew about 55 percent during the same period. The use of air conditioning is expected to grow further due to Hong Kong's increasing population and economic activity.

Energy Policy

Hong Kong has no indigenous energy resources, and relies totally on imports for its primary energy demand. To support Hong Kong's economic development, energy policy in Hong Kong aims to:

- Ensure that the energy needs of the community are met safely, efficiently and at reasonable prices;
- Minimize the environmental impact of energy production and use; and
- Promote the efficient use and conservation of energy.

The Hong Kong government has a fundamental philosophy of minimum government intervention in the business sector, which means the government intervenes only when public interest is involved. In keeping with such a free-market economic philosophy, the government considers the private sector best suited to supply energy requirements in response to market demands, and intervenes only to safeguard the interests of consumers, where necessary, to ensure public safety and to protect the environment. The energy sector consists of investor-owned electricity and gas utility companies.

Energy-Efficiency Policies

The Hong Kong government has been working on energy efficiency for more than 10 years and has reduced the emission of greenhouse gases by 17 percent from its historical high in the 1990s, according to government data.[93] Because Hong Kong's industrial sector has contracted, energy-efficiency programs in Hong Kong focus on the building sector and transportation sector, which accounted for 54 percent and 36 percent of total energy consumption in 2004 respectively.

To promote energy efficiency and conservation, an Energy Efficiency Office (EEO) was established under the Electrical and Mechanical Services Department (EMSD) in 1994 to provide the technical expertise and drive for energy-efficiency and conservation programs. The office issues codes of practice, such as building energy codes, establishes guidelines, and is actively involved in working groups and related committees in the efficient use and conservation of electricity. Additional initiatives range from energy management and database management, benchmarking, the exploration of advanced energy-efficiency technologies, and energy-efficiency labeling schemes to promoting wider use of new and renewable energy.[94]

Building Energy-Efficiency Policies and Initiatives

Building Energy-Efficiency Standards

Hong Kong's efforts to develop building energy standards started with the commissioning in 1990 of a consultant report on building energy regulations. This report recommended that Hong Kong adopt an overall thermal transfer value (OTTV) standard for the building envelope. Such a building energy-efficiency regulation was introduced in July 1995 with "suitable" OTTV for the walls and roofs of commercial buildings[95] and hotels. In practice, the code has been applied to any air-conditioned building.

In addition to the OTTV standard, which affects only the construction of the building envelope, the Hong Kong government also developed separate standards for lighting, air conditioning, and electrical equipment (all in 1998), and for elevators (2000). Thus, by 2000, these five standards together contained the same scope as more comprehensive standards such as ASHRAE 90.1 in the U.S. In 2005, Hong Kong revised all five of these standards, adding a performance-based option to the building envelope standard to encourage innovations in building designs.

The Hong Kong OTTV standard is a mandatory standard, while other codes for lighting, air conditioning, electrical equipment and elevators are voluntary.

Among the positive features of the Hong Kong policy, the standards are freely available on the Web, and each standard contains the standardized forms that users can fill out to demonstrate compliance.

A study of the design and estimated annual energy use in a representative sample of air-conditioned buildings revealed that mandatory implementation of EMSD's energy-efficiency codes for all such buildings could lead to a savings in annual electricity consumption in Hong Kong of about 8 percent.[96] Many buildings commissioned in recent years have not even met the requirements of the codes.

Appliance/Equipment Labeling and Standards

The Energy Efficiency Office has operated a voluntary energy-efficiency labeling scheme for appliances, home and office equipment, and vehicles since 1995. The scheme now covers 17 types of household appliances and office equipment.[97] The scheme has been well-received by the trade and consumers in Hong Kong, and has helped phase out less energy-efficient products from the market. According to the EEO, about half of the energy savings it has achieved has come from the scheme.

Hong Kong is the only economy among the 11 Asian economies reviewed in this study that does not have energy-efficiency standards for appliances/equipment.

EEO is now monitoring the labeling program, and will decide whether the labels should become mandatory, and whether minimum energy-performance standards should be implemented.

Other Initiatives

In addition to the building energy standard and appliance/equipment labeling program, a variety of supportive non-regulatory programs are available in Hong Kong.

Building Energy Consumption Indicators and Benchmarks

Benchmarks have been established for offices, commercial outlets, hotels and boarding houses, universities, post-secondary colleges and schools, hospitals and clinics, private cars, light-goods vehicles, medium-goods vehicles, heavy-goods vehicles, private light buses, and non-franchised buses. The web site for this program contains plots of the energy use of the buildings in a database, and also an on-line benchmarking tool that allows users to enter their energy consumption.[98]

Energy Efficiency Registration Scheme for Buildings

To promote adoption of the voluntary standards, EMSD established an Energy Efficiency Registration Scheme for Buildings in 1998. Designers, developers, property management companies, etc., can submit details of their building for assessment. If the EEO determines that the building is in compliance with the standards, a registration certificate will be issued, and the building can use the scheme's energy-efficient building logo on their documents to publicize their achievement in energy efficiency. As of December 2006, 1,722 registration certificates have been issued for 713 building venues, mainly government buildings.

Energy-Efficiency Awards

To draw public and professional attention and to encourage wider acceptance of the building energy codes, the Hong Kong Awards for Energy Efficiency and Conservation in Government were launched in 2003. The awards scheme was then adapted and launched in 2004 for the private sector under the name of Hong Kong Energy Efficiency Awards.

Energy Audit Program

Begun in 1994, the energy audits conducted by EEO cover all major government buildings and information on measures implemented to achieve energy savings in these buildings was disseminated to the private sector. A set of energy audit guidelines was published, and then augmented in 2004, for the benefit of property owners and property management companies.

Pilot Scheme for Wider Use of Water-Cooled Air Conditioning System

Launched by the government in 2000, the scheme allows non-residential buildings to use cooling towers in their air conditioning systems (which could produce electricity savings of 20 to 30 percent). At the end of October 2004, 118 applications had been received under the scheme.

Demand-Side Management (DSM) Program

The Hong Kong government and two power companies (CLP Power and Hong Kong Electric) signed demand-side management agreements in May 2000 for a three-year agreement period. Under the program, consumers received rebates from the power company, which in turn collects demand-side management incentive earnings from the Government. According to EEO, these programs led to early replacement of inefficient equipment. However, there is no information available that shows the current situation of this program.

Green Building Movement

Hong Kong is prominent in Asia in terms of non-government green building initiatives. The Building Environmental Assessment Method (BEAM) is a voluntary certification scheme launched in 1996 by the HK-BEAM Society—a non-profit organization consisting of developers, building professionals, contractors and property managers. BEAM recognizes improved environmental performance in building design and management. A study shows that if buildings complied with the exemplary energy performance criteria in BEAM version 1/96R, the savings could be as great as 32 percent; exemplary performance meeting BEAM 4/04 energy performance criteria would achieve even greater improvement.[99] Through May 2005, there have been 100 buildings or over 60 million square feet (around 5.6 million square meters) of floor space assessed by BEAM. These include 52,000 residential units, equivalent to the homes of 150,000 people or slightly over 2 percent of Hong Kong's population. The numbers make BEAM the most widely used scheme of its kind in the world on a per capita basis.

In August 2005, the Hong Kong government's Building Department released a study proposing the development of a new voluntary building rating system, the Comprehensive Environmental Performance Assessment Scheme (CEPAS). According to the study CEPAS will rate buildings on a "five-star" grading system, with 34 criteria in eight categories, ranging from hygiene, ventilation, and energy efficiency to waste management and cultural preservation during the design and construction stage. The best buildings will be given the platinum label. The other grades are gold, silver, bronze and unclassified. The certificate will be valid for five years. This system is meant to become a benchmark for all construction in Hong Kong, making environmental awareness a business plus.

However, the government's proposal of a new rating system has not received a positive response from the industry. A study by the Construction Industry Council (CIC) shows that CEPAS and BEAM embodied roughly the same scope of assessment, while BEAM has been operational for a significant period of time and is recognized and utilized by a range of major clients. There is no necessity to take forward two similar systems, according to the study, and the pragmatic way forward is to endorse BEAM as the industry environmental performance assessment system while incorporating the few desirable elements contained in CEPAS into BEAM. The HK-BEAM Society is now studying the possibility of incorporating the CEPAS features.[100]

Building Energy-Consumption Databases

The Hong Kong Energy End-Use Database was established in 1997 to give an overall view of energy consumption data and patterns in Hong Kong. The database contains categorized annual energy consumption data of Hong Kong's energy end-users. Updated annually, it contains data from 1984 to 2002. Meanwhile, the EEO has established energy-consumption benchmarks for nine different energy-consuming groups and their sub-groups. Software benchmarking tools have been made available to the public (www.emsd.gov.hk). A numbers of other types of databases have also been established, such as the Renewable Energy Installations Database.

Education Programs

The Hong Kong government has designed a series of school outreach programs that cover virtually the entire education system, from kindergarten pre-schoolers to students in primary and secondary schools and universities. An interactive education web site, EnergyLand[101] has been launched for students and the general public. At the same time, the EEO plays a monitoring role in the Scheme of Control Agreements with the power companies. Under the agreements, the power companies have the obligation to promote energy efficiency and conservation to the public. With the sponsorship of the two power companies, the Energy Efficiency Centre was opened to the public in 1996, and energy-efficiency education kits for the general studies subject for primary schools were developed. More recently, web-based energy-efficiency education kits have been designed. The government also organizes other activities and makes use of mass media to convey the message of energy efficiency.

Government Demonstration Programs

The government uses some of its buildings as showcases of energy-efficiency technologies and practice. For example, EMSD's new headquarters building employed a variety of energy-efficiency technologies to improve its performance. It used more than 2,300 building-integrated photovoltaic (BIPV) panels, the largest number in a project in Hong Kong. The panels can generate 3 to 4 percent of the electricity consumption of the building.

Life-Cycle Energy Analysis (LCEA) of Building Construction

In 2002, EMSD initiated a consultancy study titled Life-Cycle Energy Analysis of Building Construction. The study aimed to develop an assessment tool with model and data that appraises life-cycle costs and life-cycle performance of building materials and components; and provides guidelines on the use of alternative materials and systems that could help improve the environmental, energy and economic performance of buildings. Based on the study, the government developed the Life Cycle Assessment (LCA) tool[102] which is available for free on the government web site. The LCA tool provides a processing template, with design-oriented data-entry sheets and informative reporting documents for users.

India

Summary

- India is the world's sixth largest energy consumer. Its continuing population increase and rapid economic growth, along with a move toward urbanization and industrialization, has placed great strain on the country's energy resources and environment.
- Lowering energy intensity of GDP growth through higher energy efficiency is key to meeting India's energy challenge and ensuring its energy security.
- With a near consistent 8 percent rise in annual building energy consumption growth, it has increased from 14 percent in the 1970s to nearly 33 percent in 2005.
- India has just developed a first-generation building energy code that is yet to be formally adopted. Effective implementation of the code is hindered by such factors as a lack of (1) an uniform and practicable energy code; (2) clear implementation guidelines; (3) effective local implementation infrastructure for code administration and enforcement including code checking and inspections; (4) incentives from the government; (5) technical expertise; and (6) appropriate materials and equipment to meet requirement of codes, etc.
- Non-government initiatives from industry associations and private companies have played an important role in promoting the green building movement in India, a movement which has gained tremendous momentum during the past few years.

Data Profile[103]

Despite its large annual energy production, India is a net energy importer due to the large imbalance between production and consumption. It currently ranks as the world's sixth largest energy consumer, accounting for about 3.3 percent of the world's total annual energy consumption, and as the world's eleventh largest energy producer, accounting for about 2.4 percent of the world's total annual energy production.[104] More than 70 percent of its crude oil consumption is met via imports.

In terms of per capita energy consumption, India is well below most of the rest of Asia and is one of the lowest in the world.[105] But, to a great extent, this low figure is a result of India's large rural population (70 percent of the total, or about 700 million people), which still has very limited access to electricity. India's urban population is expected to grow to about 473 million in 2021 and 820 million by 2051, compared with just 285 million in 2001. Its booming metropolises, with 35 cities with populations in excess of 1 million and more joining the list, are straining the limits of its energy supply and causing serious air pollution problems. From 1980 to 2001, total energy consumption in India increased 208 percent, while per capita consumption rose 103 percent. Higher energy consumption in the industrial, transportation, and building sectors continues to drive India's energy usage upwards at a rate even faster than China.

An analysis of consumption by sectors shows that industry accounts for nearly half of final commercial energy consumption, followed by the transport and building sectors. With a near consistent 8 percent rise in annual building energy consumption growth, it has increased from 14 percent in the 1970s to nearly 33 percent in 2005. The gross built-up area added to commercial and residential spaces was about 40.8 million square meters in 2004-05, about 1 percent of the world's annual average constructed floor area. The trends show a sustained growth of 10 percent over the coming years, highlighting the pace at which energy demand in the building sector is expected to rise in India.

With the huge growth in the construction sector and changing lifestyles, there is an increasing gap between supply and demand, with the resultant effect of long hours of power cuts in cities. It is not rare for Indians to have 7 to 8 hours of power cuts every day, especially during the summer when the air conditioning load is at its peak.

In 2004, India ranked fifth in the world in carbon emissions, behind the United States, China, Russia and Japan.[106] Between 1990 and 2004, India's carbon emissions increased by an astonishing 82.5 percent, a rate surpassed only by China's 93.9 percent increase during the same time period.[107] For the coming decade, carbon emissions in India are expected to continue to increase because of low energy efficiency and rapid population growth and urbanization.

National Energy Policy

Energy is poised to be one of the biggest constraints to India's growth. Problems such as fuel shortages, an increasing dependency on imported oil, and poor financial and technical conditions of the power sector are discouraging growth in India.

Against such a background, energy policy in India focuses on 'energy for all' and intends to build an environment-friendly sustainable energy supply industry. With these primary objectives, the Planning Commission in 2006 unveiled the latest version of India's national energy policy, the Integrated Energy Policy, which is linked with sustainable development. The Integrated Energy Policy covers all sources of energy and addresses all aspects of energy use and supply including energy security, access and availability, affordability and pricing, as well as efficiency and environmental concerns. It highlights the following key elements that are needed to achieve the objective of 'energy for all';

- Markets that promote competition;
- Market-oriented energy pricing and allocation under effective and credible regulatory oversight;
- Transparent and targeted subsidies;
- Improved efficiencies across the energy chain;
- Policies that reflect externalities of energy consumption; and
- Policies that rely on viable incentives.

The Integrated Energy Policy expresses concerns over climate change and suggests a number of initiatives that will reduce greenhouse gas emissions:

- Energy efficiency in all sectors;
- Emphasis on mass transport;
- Active policy on renewable energy including bio-fuels and fuel plantations;
- Accelerated development of nuclear and hydro-electricity;
- Technology missions for clean coal technologies; and
- Focused R&D on climate-friendly technologies.

Energy-Efficiency Policies

India's first government initiative towards energy efficiency came when Parliament passed the Energy Conservation Act in 2001 and established the Bureau of Energy Efficiency (BEE) under the Ministry of Power to implement the Act. According to the Act, the target for energy savings by 2012 is 13 percent of estimated demand. The Act requires large energy consumers to adhere to energy consumption norms, new buildings to follow the Energy Conservation Building Code, and appliances to meet energy-performance standards and to display energy consumption labels.

The Integrated Energy Policy unveiled in 2006 has placed heavy emphasis on energy efficiency and conservation, with particular focus on efficiency of electricity generation, transmission, distribution and end-use. It points out that, over the next 25 years, energy efficiency and conservation will be critical to ensure energy security and economic growth.

The Integrated Energy Policy identified the following 10 leading areas where significant savings can make a substantial impact, half of which relate to the building sector:[108]

- Mining;
- Electricity generation, transmission and distribution;

- Water pumping;
- Industrial production, processes, hauling;
- Mass transport;
- Building design;
- Construction;
- Heating, ventilation and air conditioning;
- Lighting; and
- Household appliances.

Building Energy-Efficiency Policies and Initiatives

Building Energy-Efficiency Codes

India has many central and local authorities and bodies that help compile building codes and standards that are applicable at the local and national levels. As of now, there are three different codes/regulations that have been developed by national bodies:

- The Bureau of Indian Standards, National Building Code (NBC), which covers all aspects of building design and construction;
- The Bureau of Energy Efficiency, Energy Conservation Building Codes (ECBC), which target building energy efficiency; and
- The Ministry of Environment and Forests, Environmental Impact Assessment (EIA) and Clearance.

Among these codes/regulations, the ECBC is expected to have the most significant impact on building energy performance. The Indian government intends to integrate NBC and ECBC in the future.

National Building Code

Building by-laws in India fall under the purview of state governments and vary with administrative regions within the state. However, the central government realized the need to develop a unified building code to reflect the latest trends in construction. The Bureau of Indian Standards developed the National Building Code, or NBC, in the early 1980s as a guiding code for municipalities and development authorities to follow in formulating and adopting building by-laws. The voluntary code is meant to serve as a guide to all governmental and private agencies controlling building activities. It covers most aspects of building design and construction, with a small part dedicated to energy efficiency.

India revised the NBC in 2005. In the latest version, the code provides guidance on aspects of energy conservation and sustainable development in various parts and sections concerning appropriate design, usage and practices with regard to building materials, construction technologies, and building and plumbing services. The document provides general guidance on potential energy-efficiency aspects of such factors as daylight integration, artificial lighting requirements, and select HVAC design norms.

Energy Conservation Building Codes

Energy Conservation Building Codes is the first stand-alone national building energy standard/code, developed after the enactment of the Energy Conservation Act of 2001. It represents India's first effort to manage energy efficiency in buildings. However, ECBC is yet to be formally adopted by authorities.

The ECBC aims to reduce India's baseline energy consumption by supporting adoption and implementation of building energy codes. It takes into account location and occupancy of the buildings and provides minimum standards for reducing energy demand of the buildings through design and construction practices while enhancing occupants' comfort.

Unlike the NBC, which provides general guidance relative to energy without setting any limits, the ECBC lists specific maximum and minimum limitations on a number of key building features that affect building energy use. The ECBC is mandatory for large commercial buildings[109] and applicable to all buildings with a large air-conditioned floor area.[110] The code is recommended for all other buildings.

ECBC has both prescriptive and performance-based compliance paths. The prescriptive path calls for adoption of minimum requirements for the building envelope and energy systems (lighting, HVAC, service water heating and electrical). The performance-based compliance path requires the application of Whole Building Simulation Approach to prove efficiency over base building as defined by the code. There is also a system-level performance compliance option for the building envelope. This leaves the code inherently flexible and easy to adopt.

The Bureau of Energy Efficiency is the primary body responsible for implementing the ECBC; it works towards policy formulation as well as technical support for the development of the codes and standards and their supporting compliance tools, procedures, and forms. In developing the ECBC, the bureau has orchestrated a diverse group of in-country and international technical experts. It is also working closely with national and state-level government entities to administer and enforce the ECBC and other energy-related codes and standards.

Environmental Impact Assessment and Clearance

The Environmental Impact Assessment (EIA) is an important management tool for ensuring optimal use of natural resources for sustainable development. EIA was made mandatory in India under the Environmental Protection Act (1986) for 29 categories of developmental activities involving investments of Rs. 50 crore (US$11.6 million) and above. Builders and developers must receive environmental clearance from the Ministry of Environment and Forests before beginning construction. The requirement for building energy performance in the EIA is a combination of related terms in NBC and ECBC.

Council interviews with builders and developers in India for this study show that environmental clearance leads to additional delays as the clearance process is very time and resource consuming. Also, due to the absence of normative guidelines, builders and developers are often left unsure of the options that they have to adopt in their projects to make the projects environmentally sensitive.

Implementation of above codes/regulations

Building energy codes and regulations in India are still far from being well implemented. In fact, ECBC has still not been formally adopted. Effective implementation of the code is hindered by such factors as:

- Lack of a uniform and practicable energy code;
- No clear implementation guidelines;
- No effective local implementation infrastructure for code administration and enforcement including code-checking and inspections;
- Lack of incentives from the government;
- Lack of technical expertise; and
- Lack of appropriate building materials and equipment to meet requirement of codes.

Some progressive state governments have taken initiatives to legislate select measures (e.g., use of solar water heating in residential/commercial buildings, or the use of compact fluorescent lamps in public buildings), but these initiatives are too few in number to be able to make a significant impact on the country's overall energy efficiency.

Appliance/Equipment Labeling and Standards

The Bureau of Energy Efficiency's standards and labeling program, currently under development, aims to ensure the availability only of energy-efficient equipment and appliances. Until now, this program covered just nine types of equipment/appliances for labeling and three types for minimum performance standards. It is a voluntary scheme and offers no direct financial incentive for industry to participate.

Other Initiatives

Green Building Standard and Certification System

Industry associations and private companies have played an important role in promoting the green building movement in India. The Indian Green Building Council (IGBC), founded by the collaboration between the Confederation of Indian Industry (CII) and the private manufacturer Godrej, has taken steps to promote the green building concept in India. Currently, IGBC is facilitating the LEED rating of the U.S. Green Building Council in India. There are about five buildings that have been rated and 25 projects are registered for rating under the LEED system. The IGBC headquarters building (see Part II) in Hyderabad was the first platinum-rated building outside of the U.S., and has generated considerable public awareness of green building.

The LEED rating system was developed around the premise that buildings are air-conditioned, whereas in India, a large number of buildings built to date are not air-conditioned or partially air-conditioned. To bridge the demand for a rating system for non-air-conditioned buildings while taking into account the possibility of a partially air-conditioned building, The Energy and Resources Institute (TERI) has developed its own system known as GRIHA (Green Rating for Integrated Habitat Assessment) for the new large energy-consuming segment, i.e. commercial, institutional and residential buildings (new construction). This system responds specifically to India's prioritized national concerns about extreme resource crunches in the power and water sectors and rapidly eroding biodiversity. It attempts to stress passive solar techniques for optimizing indoor visual and thermal comfort and relies on refrigeration-based air conditioning systems only in cases of extreme discomfort. There are eight registered projects under GRIHA that are under construction. TERI is in the course of developing a similar standard to address the needs of other building typologies such as existing buildings.

Planned National Green Building Rating System

Now, in consultation with experts from various related fields in India, the Ministry of New and Renewable Energy Sources (MN&RE) is planning to develop a national rating system for green buildings. This system will be voluntary, to be adopted by builders and individuals alike. The MN&RE hopes to develop an incentive mechanism for this rating system.

Planned Energy Audit Program

The Bureau of Energy Efficiency has planned to mandate energy audits (by 2007) for all existing commercial buildings above a certain threshold of connected load; it would also develop mechanisms to ensure that the recommendations of the audit are implemented within a stipulated timeframe. There would thus be a large demand for energy service companies (ESCOs), and those establishing themselves more quickly would reap maximum benefits of the mandate.[111]

Demand-Side Management (DSM) Program

It would be fair to say that demand-side management is viewed by the government as the primary strategy for energy conservation in residential buildings. Studies show that implementation of demand-side management options to reduce demand for electricity through energy-efficient processes, equipment, lighting and buildings can help reduce the demand by an estimated 15 percent by 2032 in India.[112] In September 2002, five states in India established demand-side management cells at utilities, and Karnataka and Maharashtra designed pilot projects. Through 2002-03, MEDA (Maharashtra Energy Development Agency) and BESCOM (Bangalore Electricity Supply Company) initiated and completed capacity-building exercises. Since then, additional capacity-building exercises for the electric utility regulators, as well as the preparation of investment-grade feasibility reports for implementing demand-side management projects, have been under way. [113]

Renewable Energy Sources in Buildings

India is the only country that has a separate government ministry exclusively for non-conventional energy sources, the MN&RE, and it has one of the largest national programs to promote the use of solar energy.

MN&RE have initiated several programs focusing on utilization of renewable energy sources in buildings. For example, the solar buildings program disseminates information and provides financial support for the design and construction of energy-efficient and passive solar buildings. Solar buildings have been attempted in a few states. The government of Himachal Pradesh has made it mandatory to construct all its future buildings using passive design features.

Information Distribution

The Bureau of Energy Efficiency web site is a comprehensive information source for energy conservation-related developments and issues.[114] It provides an update on the related policy framework, especially in the context of EC Act 2001, as well as topical write-ups, news and highlights on India's progress with energy efficiency.

Indonesia

Summary

- Indonesia is expected to change from a net exporter of energy to a net energy importing country within the next 10 to 20 years, if energy demand follows current trends.
- The Indonesian government has formulated its Green Energy Policy, which harmonizes the concepts of optimizing renewable energy, the use of efficient technology and the creation of an energy-saving life style. The potential for energy conservation in all sectors in Indonesia is in the range of 15 to 30 percent.
- Indonesia has had energy-efficiency programs for buildings for more than 15 years, but these programs have had very limited results due to several key barriers and constraints, including lack of mandatory minimum energy performance standards and codes, subsidized energy prices that limit consumer incentives to use energy efficiently, lack of financial incentives, and weak institutional support for energy-efficiency programs.

Data Profile[115]

Indonesia is one of only two net exporters of energy among the 11 economies examined in this study, with oil and gas exports representing more than 30 percent of the nation's domestic revenues. It is the world's largest exporter of LNG, with an export of 28.6 million metric tons (MT) or 38 percent of the world's total LNG exports in 2001.

Fossil fuels, especially oil, are the main source of energy and the main source of Indonesia's domestic revenues. However, oil reserves in Indonesia have gradually been depleted while energy consumption is constantly increasing in line with the rate of economic and population growth. Indonesia currently has proven oil reserves of 5 billion barrels, which represents a 14 percent decline in proven reserves since 1994. Indonesia is expected to become a net oil importing country within the next 10 to 20 years if the energy demand follows current trends. This expectation holds true even if Indonesia implements a conservation program and drastically improves its energy efficiency.

During 1970 to 2004, average annual growth of final energy consumption in Indonesia was about 8.4 percent. The building sector (residential and commercial) is the third largest in terms of energy consumption, following the industrial and transportation sectors. In 2004, the building sector accounted for 27 percent of total final energy consumption (with industry at 39 percent, and transportation at 33 percent), and is expected to rise to 39 percent by 2030.[116]

The rate of CO_2 emissions is greater than the rate of energy consumption in Indonesia because of the higher share of fossil energy in the national energy mix. CO_2 emissions in Indonesia more than doubled from 1990 to 2004, and are expected to increase by more than 160 percent from 2004 to 2030.[117]

National Energy Policy

The national energy policy in Indonesia is enforced by Presidential Decree No. 5 of 2006. Aware of the incontrovertible trend that will see the country become a net energy importer, the Indonesian government is implementing five strategies in its energy policy to support sustainable development, by providing an adequate supply to satisfy the current domestic energy needs and securing sufficient supply for future generations:

- Energy diversification: Indonesia aims to accelerate the use of other energy sources, including renewable energy.
- Intensification in energy exploration: A major policy focus is on optimization of energy resources, which involves both promoting

renewable energy and intensifying energy exploration.

- Energy conservation: Indonesia hopes to reduce national energy consumption, without slowing national development growth. The potential to conserve energy in Indonesia is high, with estimates ranging from 15 to 30 percent.
- Energy price based on market mechanism: The government is restructuring energy pricing to gradually eliminate subsidies and promote energy conservation.
- Promotion of environmental protection: The environment has become an important element of national energy strategy, with sustainable energy supplies and utilization of them a key topic on Indonesia's energy agenda. As part of the framework supporting sustainable energy development, the Indonesian government has formulated its Green Energy Policy, which harmonizes the concepts of optimizing renewable energy, the use of efficient technology and the formation of an energy-saving lifestyle.

Energy-Efficiency Policy

Indonesia stands to gain 10 to 30 percent in energy savings from conservation strategies in all sectors. With little or no cost, savings could reach between 10 and 15 percent, while if Indonesia invests in conservation, 30 percent savings of energy could be achieved.[118]

The government of Indonesia has developed a raft of policies to promote energy conservation. In 1995, the government established the National Blueprint on Energy Conservation to outline national energy conservation measures and subsequent programs as well as activities, under the Energy and Mineral Resources Minister Decree No. 100. K/48/M.PE/1995.

In 2004, the Ministry of Energy and Mineral Resources established its Green Energy Policy, consolidating a number of programs to optimize the use of both traditional energy stocks and renewable energy and increase public awareness and behavior about energy efficiency. To enforce the implementation of its energy conservation policy, the government also enacted Presidential Instruction No. 10 of 2005, which defines the means and institutional set-up, identifying the responsibilities of state bodies and their coordination with users and other organizations. The government, through the Energy and Mineral Resources Minister Decree No. 31 of 2005, also provides a guideline for activating energy-saving measures.

Focused principally on Indonesia's greatest energy consumers, the industrial and transportation sectors, energy-efficiency policies in Indonesia address four critical areas: campaign, training and education; demand-side management (DSM); partnerships with the private sector; and energy-efficiency standards and labeling.

The partnership program addresses improvements in energy efficiency in energy-intensive industries and buildings. The program is voluntary, and aims to enhance energy efficiency by an average 20 percent. Government provides support to participating companies in the form of training, free energy audits, technical assistance and seminars and workshops on conservation. Company commitments include agreeing to conduct energy audits, implement energy-saving measures, and support the activity of energy conservation forums.

Indonesia's energy-efficiency labeling program aims to educate consumers about the energy efficiency of electrical appliances they purchase and use. Labels carry data that inform consumers about products and equipment.

Even though there is no explicit proof of energy-efficiency improvements, several indicators show that energy consumption decreased in early 2006. From January to April 2006, peak load was about 650 MW lower than of the same period in the 2005. Petroleum fuel consumption reduced from about 191,000 kiloliters per day in October 2005 to about 166,000 kiloliters per day in February 2006.[119]

Building Energy-Efficiency Policies

Building Energy-Efficiency Standard

Indonesian building energy-efficiency standards were established with funds from international sources or as part of international aid programs. In 1988 and 1989, Indonesia developed its first voluntary energy-efficiency standard for commercial, government and institutional buildings with technical assistance from Lawrence Berkeley Laboratory under an ASEAN-USAID cooperative agreement.

The standard addressed five building elements: (1) the building envelope; (2) air conditioning; (3) lighting; (4) the electrical system; and (5) service water heating. This first version of the standard drew much of its overall approach and considerable material from the 1979 Singapore standard and early drafts of the emerging 1989 ASHRAE standard in the U.S. The Indonesian standard was estimated to result in potential energy savings of about 20 percent.[120]

In 1994, Indonesia issued its Standard on Building Energy Conservation, the Method for Energy Conservation Design in Buildings. The standard remains voluntary. An APEC report from 2003 indicated that the voluntary building energy standard in Indonesia had not yet been widely adopted by builders or designers.[121]

Appliance/Equipment Labeling and Standards

The Indonesian government has been developing residential appliance efficiency standards and labeling programs since 1992. Although no standards currently exist for any products, voluntary labels have been established for five products.

Other Initiatives

Phasing out Energy Subsidies

Indonesia has long had substantial energy subsidies, which have reduced both the consumer's cost of energy and incentive to use energy efficiently. The Indonesian government has been trying to phase out oil and electricity subsidies significantly, and increased domestic petroleum product prices in March and October 2005. As a result, the difference between the subsidized price and the market price of gasoline dropped from about 60 percent to around 20 percent, while that of kerosene dropped from about 85 percent to about 60 percent.[122]

Demand-Side Management (DSM) Program

The National Electricity Company (PLN) introduced a demand-side management program in 1992 in an effort to slow the growth of power demand. PLN studied potential demand-side management programs and proposed programs to improve motor efficiency, and introduce high-efficiency lighting and time-of-use tariffs; this effort received assistance from the United States Agency for International Development (USAID). As of October 2002, the demand-side management programs had fallen far short of the targets established in the 1990s. Further information showing the recent development of the program is not available.

Energy Information Center

An Energy Information Center was formed in 2001 under the Department of Energy and Mineral Resources to enhance dissemination of energy information.

Regional Energy-Efficiency Activities

Indonesia participates in such ASEAN regional energy-efficiency activities as regional building award programs.

Japan

Summary

- Japan has emphasized energy conservation and efficiency since the 1970s oil shocks. Most specialists believe it is the most energy-efficient developed country in the world.
- Since the Kyoto Protocol was ratified in 1997, Japan has placed higher priority on environmental issues, especially the restriction of CO_2 emissions, in its energy policy.
- In the 30-plus years since Japan's government identified energy efficiency and conservation as a high priority, the country has established a multi-tiered system for promoting building energy efficiency through building energy standards and market-based incentive programs.
- Building energy standards were first enacted in 1980 and revised several times subsequently. Mandatory reporting of energy conservation measures was required for non-residential buildings starting in 2003, and for residential buildings over 2000 square meters starting in 2006.
- Market-based incentive programs include housing performance assessment and labeling systems, model environmental projects, and the Comprehensive Assessment System for Building Energy Efficiency (CASBEE) for green buildings.

Data Profile[123]

Japan is the fourth largest energy consumer in the world. Final energy consumption has been growing constantly since the mid-1980s, even in the period following the collapse of the bubble economy in the early 1990s.

Annually, Japan's GDP grew at an average rate of 1.1 percent from 1990 to 2004, and its final energy demand grew comparably at 1.0 percent per year during the same period. Energy consumption of the industrial sector remained generally steady, while demand in the residential and commercial building sectors and the transportation sector increased significantly, with an average annual growth rate of 1.9 percent and 1.5 percent, respectively. In 2004, total final energy consumption was 15 percent higher than in 1990. Industry is the largest energy-consuming sector, at 47.8 percent, followed by building (27.5 percent) and transport (24.7 percent).

According to an estimate of the Institute of Energy Economics, Japan (IEEJ), Japan's final energy consumption is expected to level out by 2020, considering Japan's economic and social trends (notably a smaller population with declining birth rates and an aging society, the upgrading of the economic and industrial structure towards a higher value-added system, and the long-term effects of various energy-saving efforts). After leveling off, final energy consumption is estimated to decrease slightly.

The growth of energy consumption by the residential and commercial sector in the future will be slower than in the past, due largely to improved efficiencies, the decrease in population and number of households, and decelerated increase in floor space for business operations.

CO_2 emissions, however, are expected to trend upward during the same period. Japan's CO_2 emissions in 2004 increased 15.3 percent above the 1990 base year level, which has raised public concern that the government target of reducing CO_2 emissions by 2 percent below the 1990 level by 2010 will be very difficult to achieve.

National Energy Policy

Japan is poorly endowed with energy resources. It suffered serious economic difficulties during the two oil crises in the 1970s. Because Japan is dependent upon imports for more than 80 percent of its primary energy supply and 99.7 percent of its petroleum, energy security has been the preeminent energy policy goal for this country. Measures taken to enhance Japan's energy security during the 1980s and 1990s included diversifying sources of energy, expanding the use of nuclear energy, and implementing strict energy-efficiency measures for the industrial, building and transportation sectors.

Since the Kyoto Protocol was issued in 1997, there have been some shifts in the basic strategies in Japan's national energy policy in response to the worldwide energy situation.[124] In 1998, the Ministry of International Trade and Industry reviewed Japan's Long-Term Energy Supply and Demand Outlook, which had been originally presented in 1994 to guide Japan's energy supply and demand through 2010. Environmental concerns, especially the restriction of CO_2 emissions, have been accorded higher priority. The review established the need for greater promotion of energy conservation and of new and renewable energy, and for fuel switching, in order to achieve the greenhouse gas emissions reduction target.

Following the 1998 outlook review, the Minister of International Trade and Industry announced an overall review of energy policy in 2000. The objectives of the 2000 energy policy can be summarized as three Es, which must be achieved simultaneously:

- Environmental Protection, aimed at reducing CO_2 emissions to counter global warming;
- Energy Security; and
- Economic Efficiency, aimed at reducing energy supply costs through deregulation and liberalization measures.

The 2000 policy focused on strong energy conservation measures in the industrial, residential/commercial, and transport sectors, and on the supply side by promoting nuclear power and renewable energy supplies.

After the Kyoto Protocol entered into force in February 2005, and in light of the recent surges in the global price of oil and tight energy supply-demand conditions, the government of Japan established a new National Energy Strategy and published it in May 2006. In the 2006 policy, the 3Es are still the three main pillars, with energy security receiving the highest priority. Reducing greenhouse gas emissions to achieve Kyoto Protocol targets is also a pillar. Reflecting Japan's status as a major international voice on economic and environmental matters, the 2006 policy sets forth three objectives, with energy efficiency being one of the key measures to achieve these objectives:

- To establish Japan's energy security;
- To solve the energy problem and the environment problem together; and
- To contribute actively to a worldwide solution to energy problems.

Energy-Efficiency Policies

Japan's energy-efficiency performance is remarkable. According to most specialists, it is the most energy-efficient developed country on Earth.[125] Its energy consumption per unit of GDP is the lowest in the world, due to various conservation measures pursued by the government and adopted by Japanese citizens.

Because Japan is resource-poor and must import most its energy from the Middle East, Japan has emphasized strict efficiency and conservation measures since the 1970s shocks. The Japanese have put in place a comprehensive energy-efficiency program that reaches across all sectors of the economy. In 1979, the Energy Conservation Law established standards for all energy-consuming sectors (including vehicles, factories, commercial buildings, residential housing, electrical household appliances, office equipment, etc). Amended several times, the last major revision to this law was in 1999.

To force households and companies to conserve, the Japanese government used the Energy Conservation Law to raise the cost of gasoline and electricity far above market levels. The government in turn used these tax revenues to help Japan take the lead in investing in such renewable energies as solar power, and more recently, home fuel cells.

In 1998, in order to achieve its target set forth at the Kyoto Conference on Climate Change (COP 3), Japan reviewed its efficiency measures. These measures were further reviewed in 2000 and 2006, and are expected to be expanded and strengthened in the future to promote additional energy conservation in the residential, commercial and transport sectors. The government will further restrict energy consumption on the demand side and will also introduce financial incentives aimed at encouraging the use of more energy-efficient household appliances and automobiles.

Building Energy-Efficiency Policies and Initiatives

Building Energy-Efficiency Standards

Japan's building energy regulations are part of the national Energy Conservation Law. Within the Energy Conservation Law, several sections apply to the building sector. Although these standards are defined as voluntary, there are numerous aspects that are enforceable. For example, starting in 2003, a mandatory report on energy conservation measures prior to new construction, extension, alteration, as well as major renovations, of any commercial building must be reviewed and approved. In 2006, this requirement was also extended to any residential building larger than 2,000 square meters.

There are separate building energy standards in Japan for "buildings," i.e., non-residential commercial buildings, and "houses," i.e., residential buildings. The commercial standard was first adopted in 1979, and the residential standard, in 1980, as parts of Japan's national Energy Conservation Law. The current versions of the two standards were adopted on March 30, 1999, although further additions have since been made to broaden their scope or reporting requirements.

The residential building energy standard ("Design and Construction Guidelines on the Rationalization of Energy Use for Houses") has both a prescriptive and a performance option. The standard lists such prescriptive requirements as heat transfer coefficients, resistance of insulation materials, requirements for adding air barriers, heat transfer coefficients for doors, and "summer insulation entry rate," i.e., summer solar heat gain coefficients (SHGC), of windows, etc. The 1999 revision also added a performance option that specifies criteria for the maximum allowable annual heating and cooling loads, or heat loss coefficient and summer solar heat gain coefficient. The commercial building energy standard ("Criteria for Clients on the Rationalization of Energy Use for Buildings") is a performance standard.

Jurisdiction

The development of building energy standards falls under the jurisdiction of the Ministry of Land, Infrastructure and Transport (MLIT), which was established in 2001 through the consolidation of the former Ministry of Construction, Ministry of Transportation, National Land Agency, and the Hokkaido Development Agency. However, the standards are the joint responsibility of MLIT and the Ministry of Economy.

In addition, the Energy Conservation Center of Japan (ECCJ), a non-government organization established in 1978 with numerous industrial partners to promote the efficient use of energy, protect against global warming, and promote sustainable development, is also active in providing technical assistance in energy-efficient building construction and operations.

Compliance

Government statistics show that the compliance rate has been growing in recent years, increasing from 13 percent in 2000 to 32 percent in 2004 for residential buildings, and from 34 percent in 1999 to 74 percent in 2004 for commercial buildings. The higher compliance rate for commercial buildings can be attributed to the mandatory reporting of energy conservation strategies since 2003. Now that mandatory reporting is also required for residential buildings over 2,000 square meters, compliance is likewise expected to approach 80 percent as well.

Appliance/Equipment Labeling and Standards

The Top Runner Program

Since 1998, Japan has been implementing the Top Runner Program to set energy conservation standards for home and office appliances and a fuel economy standard for automobiles. In many countries, the energy efficiency of electrical appliances is enhanced by minimum efficiency performance standards. Japan followed a different strategy. Instead of setting a minimum standard, Japan's Top Runner Program searches for the most efficient model on the market and then stipulates that the efficiency of this top runner model should become the standard within a certain number of years. By the target year, each manufacturer must ensure that the weighted average of the efficiency of all its products in that particular category is at least equal to that of the top runner model. This approach eliminates the need to ban specific inefficient models from the market. At the same time, manufacturers are made accountable and, perhaps most importantly, they are stimulated to develop products voluntarily with an even higher efficiency than the top runner model. In the Kyoto implementation plan, Top Runner is projected to prevent 29 million tons of CO_2 emissions by 2010, which amounts to 3 percent of the Japan's greenhouse gas emissions target for 2010. As of August 2005, 18 products have been designated top runners.

Energy-Efficiency Labeling System

Japan's voluntary energy-efficiency labeling system was introduced in 2000. As of April 2005, labeling has been applied to the following 13 products: air conditioners, refrigerators, freezers, fluorescent lights, televisions, space heaters, gas cooking appliances, gas or oil water heaters, electric toilet seats, computers, magnetic disks, and transformers.

Other Initiatives

In addition to the mandatory building standards, Japan also has implemented an assortment of voluntary programs to stimulate building energy efficiency.

The Housing Quality Assurance Law (2000)

This voluntary housing performance labeling system is meant to protect consumers. It contains standardized criteria for evaluating a wide variety of housing materials performance, including the building's structural stability, fire safety, indoor air quality, acoustics, lighting and thermal environment, consideration for the aged, etc. Building energy efficiency is rated as part of the assessment of the building's thermal environment. The government establishes the assessment standards and registers private companies qualified to do the assessments.

Environmentally Symbiotic Housing Model Projects (1993)

MLIT subsidizes one-third of the costs for surveys, planning, and installation of "environmentally symbiotic facilities," including permeable pavement or facilities that utilize natural energy sources or those that use recycled materials.

Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)

CASBEE is a green building rating system developed by the Japan Sustainable Building Consortium in 2004 to assess the environmental efficiency of buildings. It is a voluntary program being implemented by local governments, with training for assessors and third-party assessments. Developers, builders, architects and others can download a program that allows them to assess any new building or renovation on their own. They may also hire trained architects who have passed a CASBEE assessor exam to conduct the assessment.[126] CASBEE has received a great deal of publicity among both government and industry, as well as in other Asian countries such as China (where the CASBEE rating system has been adopted for Beijing's Green Olympic Building Assessment System) and India.

Training Programs

The government provides voluntary training of construction techniques for building contractors to construct buildings that follow the newest energy-saving standard for non-residential buildings.

Financial Incentive

The government provides financing of up to 2.5 million yen through the Housing Loan Corporation to adapt houses to energy-saving standards.

Energy-Efficient Product Retailer Assessment System

Introduced in 2003, this system gives recognition to retailers who actively promote energy-efficient products or provide appropriate energy conservation information.

Other Programs

In addition, the government has programs to promote high-efficiency boilers, air conditioning systems, and energy management utilizing information technology.

Malaysia

Summary

- Malaysia is an energy exporter. However, its high growth rate in energy consumption is gradually diminishing Malaysia's fossil fuel resources, and will cause constraints on its ability to meet future energy demand.
- The Malaysian government has recognized that the nation has to be more prudent in its energy consumption; energy efficiency is emphasized in Malaysia's energy policy so that the indigenous resources can last longer, thereby enhancing the security of supply in the future.
- In Malaysia, a voluntary code of practice for non-residential buildings has been developed, some energy-efficient technologies have been identified as entering the building industry market, and a number of buildings with energy-efficient features exist. But plans for implementing the code are still being developed and efforts in other areas, except for standards, are still in the beginning stage.

Data Profile[127]

Malaysia is an energy-exporting country. Its current reserves-to-production ratio will make its indigenous oil last until 2017. By then, 100 percent of its oil needs will have to be imported if new reserves are not discovered. While it sounds much more promising for natural gas, with a reserves-to-production ratio of around 45 years, the country's domestic needs are growing very rapidly. Malaysia is now unable to meet this new and extra domestic demand, since its reserves are all committed to meet and honor existing domestic and export contract agreements. [128]

For the last two decades or so (with the exception of a few years during the financial downturn of the late 1990s), Malaysia has undergone fast economic growth with the inevitable result of higher energy consumption. Total final energy consumption grew at an average rate of 7.3 percent per year, with a total increase of 3.7 times from 1980 to 2002. Studies show that Malaysia's economy and energy demand will continue to grow robustly through 2030, with final energy consumption expected to grow at 3.9 percent annually. By 2030, total energy demand is expected to be almost three times that of 2002, and 14 times that of 1980.

The industrial and transport sectors have been the biggest energy consumers during the last decade, accounting for around 42.6 percent and 40.0 percent of total energy consumption in 2002 respectively, while the building sector accounted for 17.3 percent of the total consumption. From 2002 to 2030, the industrial sector will have the highest growth rate of 4.3 percent, followed by transport at 3.9 percent and buildings at around 3 percent.

From 2002 to 2030, CO_2 emissions from the energy sector are projected to grow at 4.2 percent per annum, reaching 414 million tonnes of CO_2 in 2030, a three-fold increase over 2002.

National Energy Policy

Rapidly increasing energy demand, depleting indigenous resources and steeply escalating energy prices are the main problems for Malaysia in the energy-consuming sector, and this country is trying to address the energy issue from three angles: the supply side, the demand side, and the environmental side. In the national energy policy, three principal objectives are instrumental in guiding the future energy sector development:

- The Supply Objective: To ensure the provision of adequate, secure and cost-effective energy supplies through developing indigenous energy resources both non-renewable and renewable energy resources using the latest cost options and diversification of supply sources both from within and outside the country;

- The Utilization Objective: To promote the efficient utilization of energy and discourage wasteful and non-productive patterns of energy consumption; and
- The Environmental Objective: To minimize the negative impact of energy production, transportation, conversion, utilization and consumption on the environment.

To achieve the national objectives, the government is pursing the following strategies:

- Secure supply: Diversify fuel types, sources, and technology, maximize the use of indigenous energy resources, secure adequate reserve capacity for contingencies, secure adequate reserve margin for generation, upgrade transmission and distribution networks and distributed generation;
- Sufficient supply: Forecast demand properly, set the right energy price, and formulate plans to meet demand;
- Efficient supply: Promote competition in the electricity supply industry;
- Cost-effective supply: Promote competition and provide indicative supply plans to meet demand based on least-cost approach using power computer software;
- Sustainable supply: Promote the development of renewable energy and co-generation as much as possible;
- Quality supply (low harmonics, no surges and spikes, minimal variation in voltage): Match quality with customer demand with variable tariffs;
- Efficient utilization of energy: use bench marking, auditing, financial and fiscal incentives, technology development, promotion of energy service companies (ESCOs), labeling, ratings, correct pricing, energy managers; and
- Minimizing negative environmental impact: Monitor the impact, improve efficiency of utilization and conversion, and promote renewable energy.

Energy-Efficiency Policies

Energy-efficiency promotion has been formally part of Malaysia's national energy policy for the last decade.

In Malaysia, the efficiency of energy supply is governed by three laws.[129] However, in terms of effective and efficient utilization of energy, there are no laws enacted so far. To promote efficient utilization of energy, the government has enacted principles and measures on energy efficiency. Principles include:

- Improvement of the transformation plant (better efficiency of power plants, refineries, LNG plants), transmission and distribution sectors (e.g. lowering of electricity losses), up to final energy supply;
- Improvement of energy efficiency at the end-use level, mainly through energy savings in the existing industrial sector, building sector and transport sector;
- Implementation of innovative processes using new technologies; and
- Implementing co-generation, which is recognized to improve production efficiency, particularly at the time when natural gas becomes more available.

During the 9th Malaysia Plan Period (2006-2010) the implementation of energy-efficiency programs will focus on energy-saving features in the industrial and commercial sectors. In this regard, energy-efficient features such as efficient lighting and air-conditioning systems as well as establishing a comprehensive energy management system will be encouraged.

Building Energy-Efficiency Policies and Initiatives

Building Energy-Efficiency Standards

In 1986 and 1987, Malaysia developed a first draft of energy-efficiency guidelines for commercial buildings, launching it as a national voluntary guideline in December 1989.

The scope of the guidelines included: (1) building envelope; (2) air conditioning; (3) lighting; (4) electrical power and distribution; and (5) energy management. This first version of the guidelines drew much of its overall approach and considerable material from the 1983 Singapore standard and early drafts of the emerging 1989 ASHRAE 90.1 standard in the U.S. The guidelines included appendices on sample overall thermal transfer value (OTTV) calculations and energy and cost impacts.

In 2001, the guidelines were revised and incorporated into Malaysian Standard (MS) 1525 as a "Code of Practice on Energy Efficiency and use of Renewable Energy for Non-residential Buildings." This new version is reported to contain additional emphasis on building architectural features and passive solar compliance options.[130]

Compliance

Compliance with this code of practice has been voluntary. In 2006, the code was revised and updated again, and is undergoing public review at the time of this writing. Actions are also now underway to incorporate several sections (building envelope, air conditioning, and lighting) of the latest version of the code into the Uniform Building By-Laws so that they become mandatory.[131]

Jurisdiction

The Ministry of Energy, Water and Communications (MOEWC) (formerly the Ministry of Energy, Communications and Multimedia) has been the responsible ministry for developing and promoting the energy-efficiency buildings standards.

Implementation and Impact

In the late 1980s, potential savings of 20 percent were estimated from the use of the code.[132] However, Asia Business Council researchers are not aware of any information about the use of the building energy code over the past 15 years, or about how many buildings might have complied with part or all of it on a voluntary basis. There are indications of the general effectiveness of Malaysian energy policies applied to buildings. In lighting, for example, more efficient products such as compact fluorescent lamps or low voltage quartz halogen lamps with glass mirror reflector and dichroic reflector coating have been widely used in place of less-efficient products. For air conditioning, more efficient products are used such as multi-compressor chillers, variable air volume systems, etc., and the ice storage technique is used in air-conditioning systems to reduce peak power demand. A number of new buildings in Malaysia since 1990 have adopted energy-efficiency designs that exceed the requirements of MS 1525.

Appliances/Equipment Labeling and Standards

In December 2003, the High Efficiency Electric Motor Agreement (HEEMA) was formalized under the Suruhanjaya Tenaga (Energy Commission)—Danish International Development Agency capacity-building project. The HEEMA is a voluntary agreement signed by eight local motor manufacturers, dealers and importers to promote high-efficiency motors in Malaysia and to minimize and ultimately eliminate low-efficiency motors from the local market. On the same day, nine companies from the Malaysian refrigerators, manufacturers and importers association signed a voluntary Memorandum of Understanding (MOU) on the promotion of energy-efficient refrigerators. The implementation of the motor labeling and refrigerator labeling is on a voluntary basis.

Other Initiatives

Energy Center

There has evidently been an effective, long-term collaboration between government and academia in Malaysia that has contributed to the development and refinement of the building energy standards. Considerable technical capabilities for energy efficiency are resident in Pusat Tenaga Malaysia (PTM), or the Malaysia Energy Center. This organization was established in 1998 as a focal point for various energy-related government and private-sector activities, including energy planning and research, energy efficiency, and technological research, development and demonstration. While PTM is registered as a non-profit company, it receives administrative support from MOEWC.

Demonstration Projects

Malaysia has a number of buildings to demonstrate energy-efficient features. The most famous ones include the Securities Commission building and the Low-Energy Office Building (LEO) (see Part II for the cases).

Building Energy Benchmarking

The PTM has initiated a web-based energy-benchmarking program for office buildings that aims to establish a database for benchmarking energy consumption and efficiency. The program description is available on the PTM web site, allowing readers to download and complete a 4-page office building benchmarking form.[133]

Building Energy Audits

One of the most promising programs in Malaysia is the energy auditing program that aims to encourage industries and building owners to audit their energy use with a goal of reducing energy costs and increasing productivity. Under this program, about 40 buildings and industries have been audited between 1993-1995 through bilateral and multilateral cooperation. This is the first energy audit program carried out under the Malaysia Development Plan 1991-1995.[134] Further energy audits have been done since then—audits of 12 government buildings in 2002 and audits of 48 industries under the Malaysia Industrial Energy Efficiency Improvement Project since July 2000.

Financial Incentives

As for financial incentives, there is provision for import duty and sales tax exemption on equipment used in energy conservation that is not produced locally. Equipment purchased from local manufacturers is given sales tax exemption.

New Energy Tariff

Energy prices for commercial buildings are highly subsidized in Malaysia. A non-subsidized price for electricity is more than double the subsidized price. A new electricity tariff was implemented in June 2006 to discourage inefficient energy use amongst the larger consumers.[135]

Regional Energy-Efficiency Activities

Malaysia actively participates in ASEAN regional energy-efficiency activities. Such activities include (1) participation in the development of regional energy benchmarking of buildings and (2) regional energy-efficient building award programs.

Philippines

Summary

- Energy consumption in the Philippines has grown more rapidly than economic output, as energy-to-GDP ratios have increased in different sectors over the past decade.
- Attaining energy independence is the over-arching objective for the energy sector in the Philippines. While emphasizing the development of indigenous energy sources that will eventually lead to increased self-reliance, promoting energy efficiency is seen as another effective approach to achieve the objective.
- The Philippines has had mixed results in its energy programs over that past 15 years. The government has taken substantial action to establish a mandatory building energy code and appliance/equipment standards and labeling. However, there is a lack of significant implementation or enforcement of the building energy code.

Data Profile[136]

Energy consumption rose more quickly than economic growth in the Philippines between 1980 and 2004. GDP grew at an average rate of 6.0 percent, while total final energy consumption increased by a rate of 8.3 percent. As a result, GDP in the Philippines increased about 85 percent, in contrast to a more than 140 percent increase in total energy consumption during the same period. It is estimated that energy consumption in the Philippines will continue to rise at an average rate of 4.5 percent from 2004 to 2030, with a total increase of around 210 percent.

The transport sector is the largest energy consumer in the Philippines in 2004, accounting for 48.4 percent of the total, followed by the building sector (25.8 percent) and the industrial sector (22.6 percent).

As for the building sector specifically, energy consumption of this sector increased more than 80 percent from 1980 to 2004, and is estimated to increase more than 185 percent from 2004 to 2030.

Energy self-sufficiency in the Philippines was 53.9 percent in 2003. The country's dependence on energy imports will continue on a more restrained level at an average annual growth rate of 3.9 percent over the ten-year planning period due to policies that promote greater utilization of indigenous fuels.[137]

The Philippines is notable among reviewed economies in utilizing renewable energy such as biomass, solar and wind. It is the world's second largest producer of geothermal power, and is also exploring the use of other renewables such as wind energy. The renewable power share in the power generation mix was 42 percent in 2003, rising from 38 percent in 2002.[138]

National Energy Policy

The Philippines has a wealth of potential energy resources. However, indigenous energy sources are underdeveloped, which hampers the Philippines' progress in energy self-reliance. The main theme of the Philippines' energy policy is to seek growth and self-sufficiency in energy production and to provide adequate supply to meet increasing energy demand, while environmental and social aspects of energy are also emphasized. The goals of the national energy policy include:

- Supply security and reliability;
- Energy affordability and accessibility;
- Environmental quality; and
- Consumer protection.

With energy independence as the over-arching objective, the Philippine Energy Plan (PEP) of 2005 calls for the development of indigenous energy resources that will eventually lead to increased self-reliance. At the same time, promoting efficient and judicious utilization and conservation of energy is seen as another effective approach to achieve the objective and to keep greenhouse gas emission levels at a lower growth rate. The Department of Energy (DOE) has set forth a goal of a 60 percent self-sufficiency level in 2010, and hopes to achieve this by:

- Increasing indigenous oil and gas reserves;
- Aggressively developing renewable energy resources;
- Increasing the use of alternative fuels;
- Forging strategic alliances with other countries; and
- Promoting a strong energy-efficiency and conservation program.

Energy-Efficiency Policies

Currently, the DOE is promoting the "EC (energy conservation) way of life" and pursuing an energy-efficiency program that covers two areas: fuel efficiency and conservation, and power conservation and demand-side management. The objectives of the program include:

- Enhancing consumer understanding of energy use;
- Lowering consumer energy expenditures without constraint on productivity;
- Reducing capacity/ transmission expansion requirements; and
- Reducing greenhouse gas emissions.

Policies and strategies in the program include:

- Promoting energy-efficiency measures through the existing specific programs to sustain economic, environmental and social benefits;
- Enhancing private-sector involvement in the energy-efficiency program through the development of an Energy Service Industry and the promotion of energy-efficient technologies, goods, and services at the lowest possible price, with the highest possible quality;
- Promoting voluntary agreements with energy-intensive industries;
- Continuing implementation and expansion of the appliance energy standards and labeling program;

- Encouraging consumer purchase of more energy-efficient technologies by providing accurate information on these products;
- Integrating energy-efficiency concepts in the procurement practices of the government;
- Integrating energy-efficiency policies in all sectors of the economy;
- Periodic program monitoring and evaluation to assess the effectiveness of the energy-efficiency program;
- Intensifying collaborative efforts with the private sector, trade allies and industry associations;
- Developing energy-efficiency intensity indicators for each sub-sector;
- Expanding opportunities for energy-efficiency and load management through competitive bidding vis-à-vis other resources; and
- Promoting international cooperation on energy technology application.

Both the government and private sector have initiatives to improve energy efficiency. Government efforts include providing direct services and regulatory measures, while the private sector will focus on market-driven services. Market transformation activities, such as in appliances and lighting, will be the responsibility of both government and private sectors.

Building Energy-Efficiency Policies and Initiatives

Building Energy-Efficiency Code

In 1988 and 1989, the Philippines developed a first-draft energy-efficiency code for buildings, The Guidelines for Energy Conserving Design of Buildings and Utility Systems, which is mandatory. The scope of the code included: (1) building envelope; (2) air conditioning; (3) lighting; (4) electrical; and (5) service water heating. This first version of the standard drew much of its overall approach and considerable material from the 1979 Singapore standard and early drafts of the emerging 1989 ASHRAE standard in the U.S.

The process of adopting the first energy-efficiency code took several steps. In 1992, the Department of Public Works and Highways (DPWH), which is responsible for issuing the National Building Code (NBC), approved the building energy code as a referral code. The NBC and all referral codes are mandatory. In 1994, the government changed the building energy referral code into a national building energy code to cover all new buildings with an installed air conditioning electrical demand of at least 150 kW.[139] In October 2005, the government began upgrading the code, which it expects to finish in 2007.

In the mid-1990s, major changes occurred in the building energy code's implementation, and responsibility for enforcement shifted to the Department of Interior and Local Government (DILG), with enforcement intended to occur at the local level. This approach is consistent with enforcement and compliance approaches for buildings in many other countries.

There has been no sign of effective implementation of the Philippines' mandatory national building energy code. In 1997 and 1998, studies indicated that the requirements of the energy code were not being followed.[140] In the late 1990s, the local electricity distribution company for Manila (MERALCO) suggested that it thought it would be capable of effectively managing compliance, threatening not to hook up non-compliant buildings to the electrical grid. Eight years later, there was no evidence of implementation of the 1994 energy code, or compliance with it. In a recent presentation on energy-efficient lighting by DOE, the lack of implementation and out-of-date status of the 1994 energy use guidelines were cited as barriers to energy conservation.

Appliance/Equipment Labeling and Standards

The Philippines began its first energy-efficiency labeling and standards program for air conditioners in 1992. Currently, there are four subprograms: efficiency standard and labeling for room air conditioners; energy labeling for refrigerators and freezers; fluorescent lamp ballast energy-efficiency standard; and performance certification of fans and blowers. These programs are mandatory and are estimated to contribute a cumulative potential energy savings of 0.9 million barrels of fuel oil equivalent (MMBFOE) in 2002 to 9.7 MMBFOE in 2011.

The Philippine Efficient Lighting Market Transformation Project (PELMATP) is a five-year project led by DOE with support from the Global Environment Facility (GEF) and the United Nations Development Program (UNDP). The project aims to address the barriers to the widespread utilization of energy-efficient lighting systems in the Philippines and contribute to the reduction of greenhouse gas emissions to the environment.[141]

Other Initiatives

Energy Management of Government Buildings

To make government buildings a showcase of energy efficiency, in late 2000 the Philippines launched an "Enercon program" that required all government agencies, bureaus and offices to reduce their annual electricity and fuel consumption by at least 10 percent by adapting energy-efficiency technologies and practices.[142] The program requires monthly reports be submitted to DOE. An "Energy Efficient Best Practices Awards in Government" program was set up to recognize agencies that achieve this objective.

In 2002, DOE established a Government Energy Management Program to implement energy-efficient technologies and practices in all government facilities. However, there is no information disclosing the efficacy of this program over the past several years.

Labeling of Government Buildings

The DOE has an Energy Spot Checks program wherein inspectors visit the national government agencies' buildings and issue energy ratings based on energy use criteria. Energy ratings are then placed in the lobbies or entrances of the buildings that have been spot-checked.

Energy Management Services

This program assists commercial and industrial establishments in identifying effective measures towards more efficient use of energy. These energy-management services, most of which are presently being provided by the government, include energy audits, financing, information on energy utilization performance, technology promotions, and recognition programs. The private sector (engineering companies and/or energy service companies) are expected to become a major player in providing these services in the future.

Information and Education Campaign

The government has two major programs in this area: the Power Conservation and Demand Management (Power Patrol) and the Fuel Conservation and Efficiency in Road Transport (Road Transport Patrol). The Power Patrol directs its information and education efforts to the residential, commercial, and industrial sectors mainly through seminars and workshops.

Demand-Side Management (DSM) Program

There is an ongoing initiative to review, amend and improve the 1996 Demand-Side Management Regulatory Framework. To date, however, the national demand-side management program has remained in the pre-implementation stage.

Regional Energy-Efficiency Activities

The Philippines participates in ASEAN regional energy-efficiency activities. Such activities include participation in regional energy-efficient building award programs. Several Philippine buildings have been cited in the ASEAN Energy Awards.

Green Building Movement

According to the World Green Building Council, there is a move to organize a Philippine Green Building Council.

Singapore

Summary

- Singapore is a city-state with no natural resources and no domestic oil reserves, and depends entirely on imports for its energy needs. To reduce its increasing rate of energy consumption, Singapore's national energy policy focuses on energy conservation and efficient use.
- Energy-efficiency policy in Singapore is closely integrated with its environmental policies. Clean energy, energy efficiency and conservation are all key strategies for enhancing sustainable development and mitigating greenhouse gas emissions in Singapore's environmental policy.
- Singapore was the one of the first countries in the region to develop and implement a building energy code, and ASEAN countries have used it as a reference model.
- Now, a comprehensive and exemplary set of mandatory and voluntary building energy-efficiency and green building programs that span the whole life cycle of a building are available in Singapore. The country has developed since the 1980s both the institutional infrastructure and expertise to handle the enforcement of its policies and programs.

Data Profile[143]

Singapore's energy needs have grown in tandem with its economic growth. Over the period from 1980 to 1995, average annual growth rate in energy demand was 11.9 percent, much higher than the 7.6 percent growth rate of GDP. Energy consumption in Singapore can be attributed to three main sectors, i.e. industry (about 29 percent), residential and commercial buildings (about 34 percent), and transport (about 37 percent).

In the tropical climate of Singapore, much of the electricity consumed in buildings is for air conditioning and refrigeration (around 58 percent of total consumption of the building sector). In particular, energy consumption in commercial buildings, which are mostly designed to be fully air-conditioned, represents about 57 percent of the building sector's total consumption.

The carbon intensity (CO_2 emissions per unit of GDP) in Singapore was decreasing at an average rate of 8.8 percent between 1980 and 2002. The government's target is to reduce the carbon intensity to 25 percent below 1990 levels by 2012.

National Energy Policy

As the most highly industrialized and urbanized economy in Southeast Asia, Singapore is a city-state with no natural resources and no domestic oil reserves. It depends entirely on imports of fossil fuels and natural gas for its energy needs, making its economic and social development extremely vulnerable to factors affecting global energy supply. Since the 1970s, energy security has been a top concern on Singapore's energy agenda.

Singapore's energy policy places emphasis on environmental sustainability. Singapore is committed to slowing down or reducing its greenhouse gas emissions, and is focusing on clean energy, energy efficiency and conservation as key strategies to enhance sustainable development and mitigate greenhouse gas emissions.

In general, the national energy policy stresses six key strategies, with conservation and efficiency the top priority:

- Focus on conservation and efficiency: There is a clear focus on energy conservation and efficient use in Singapore's national energy policy in order to reduce the growth rate of energy consumption, enhance sustainable development, and mitigate greenhouse gas emissions.[144]

- Enhance its role as a regional petroleum refining and trading center: Despite its lack of domestic oil resources, Singapore is one of the major petroleum refining and trading centers of Asia. Securing its role as a regional petroleum refining and trading center will help reaffirm its national energy security.
- Promote the country as a regional hub for an integrated gas pipeline network: Use of natural gas is expected to play a major role in the energy market. Singapore is studying the viability of building a liquefied natural gas (LNG) import terminal, thereby freeing itself from dependence on neighboring states (Malaysia and Indonesia) for its gas supply.
- Restructure and privatize the power sector: Singapore is in the process of restructuring and privatizing its electric power sector, which will result in the transformation from a monopoly to a competitive market.
- Energy reserves: In Singapore, existing power plants are running with higher levels of reserve capacities, which is regarded as necessary for a nation like Singapore.
- Participate in overseas exploration and production: Although Singapore does not produce oil domestically, local companies have become active in overseas exploration and production.

Energy-Efficiency Policies

In Singapore, energy-efficiency policy is closely integrated with environmental policies. The National Energy Efficiency Committee, the key agency to address concerns over increasing energy consumption and to recommend policy measures to improve energy efficiency in Singapore, has recently been expanded in scope to cover climate change issues and has been renamed the National Climate Change Committee (NCCC).

Energy conservation policy in Singapore targets five areas: building, households, industry, transportation, and research and development. Main strategies include:

- Promoting energy conservation through the efficient use of energy in the industrial, building, transportation and consumer sectors;
- Encouraging the use of cleaner energy sources such as natural gas and renewable energy sources; and
- Promoting Singapore as a location for test-bedding of pioneering energy technologies and as the hub for development and commercialization of clean energy technologies.

Building Energy-Efficiency Policies and Initiatives

An exemplary set of mandatory and voluntary building energy-efficiency and green building programs are available in Singapore. These programs are mainly coordinated via the Building Energy Efficiency Master Plan formulated by the Building and Construction Authority (BCA). The plan contains programs and measures that span the whole life cycle of a building. BCA reviews the plan and updates it annually to incorporate the latest plans and changes necessary to keep building energy efficiency in Singapore an ever-improving goal.

Building Energy-Efficiency Code

Singapore was the one of the first countries in the region to develop and implement an energy code. Developed in 1979, its first energy code drew much of its overall approach and considerable material from the 1975 version of the ASHRAE energy standard in the U.S. The scope of the standard included: (1) the building envelope; (2) air conditioning; (3) lighting; (4) electrical systems; and (5) service water heating. Since the first version was adopted in 1979, the standard has been revised twice, in 1989 and 1999.

The 1989 version of the standard contained requirements for roof and wall insulation, air leakage, location of entry doors, zoning for temperature control, sufficient electric power metering, switching off air conditioning automatically in hotel guest rooms when unoccupied, and data-logging facilities for collecting data for energy audits.[145] In

1999, three codes of practice for buildings were updated: (1) Code of Practice for Energy-Efficiency Standard for Building Services and Equipment; (2) Code of Practice for Mechanical Ventilation and Air conditioning in Buildings; and (3) Code of Practice for Artificial Lighting in Buildings. The 1999 revisions, made effective in mid-2000, also included a new system analysis tradeoff compliance option in addition to the prescriptive compliance that had been in effect since 1979.

According to the BCA, further reviews will be targeted every three years, or sooner upon request by local professional institutes and boards.

Singapore's energy code has been mandatory since the first version, and the country has gained a reputation for strong and effective enforcement of its energy code.

Singapore has had extensive compliance guidelines available since the early 1980s. Until 2000, the Singapore energy code contained only a prescriptive compliance option. In 2000, a new system analysis compliance option became available to allow tradeoffs during compliance. This new method uses a software-based set of tools developed and made available by the National University of Singapore (NUS). It can be used by engineers, architects and building services professionals to demonstrate compliance with prescriptive and energy performance standards relating to air-conditioned buildings.[146]

The BCA has been the government entity responsible for developing and enforcing the energy-efficiency building codes of practice. It appears to have developed since the 1980s the institutional infrastructure and expertise to handle the enforcement of the building energy code requirements. The BCA also has ready access to additional technical resources through an excellent and long-standing collaboration with NUS, which provides technical and R&D input to various building energy-efficiency programs, such as analysis of energy code impacts and improvements, development of energy-efficiency indices and benchmarking of building performance, and compliance tools and software development.

An innovative aspect of the Singapore energy code within the region is that the code and supporting documentation is available on the Web. Several additional web sites contain a wealth of information about the energy-efficiency programs, including copies of the energy code provisions, compliance forms and tools, plus information and application forms for various related programs. For example, BCA and NUS have developed a joint Building Energy & Research Information Centre web site that serves education and outreach objectives, making available a wide range of data, tools, and information about the energy code and energy efficiency.[147] These web sites form a major resource, especially in comparison to some other countries in the region, where information about building energy code and energy-efficiency programs is not as easily available to review and use.

Appliance/Equipment Labeling and Standards

Currently, Singapore's mandatory minimum energy performance standard program covers only one product, the window type air conditioner.

The Singapore Green Labeling Scheme (SGLS), a voluntary labeling scheme, was launched in 1992 by the Ministry of the Environment. The scheme promotes the use of a wide range of environmentally friendly products, including ballasts. Generally, no energy performance is shown on the green label. A new comparative label, the Energy Labeling Scheme, was launched in 2002 under the umbrella of the SGLS. Currently, only two categories of electrical appliances (refrigerators and air conditioners) are covered by the scheme.

Other Initiatives

The Singapore government is running a wide variety of non-regulatory programs to promote building energy efficiency. Important ones are as follows:

Green Mark Incentive Scheme (GMIS)

In January 2005, BCA launched the Green Mark Scheme in order to promote environmental awareness in the construction and real estate sectors. The "Green Mark" is used to rate the environmental friendliness of a building. It encourages the adoption of various green building technologies to achieve a sustainable built environment by improving energy efficiency, water efficiency, and indoor environment quality and environmental management. The scheme is available for both new and existing buildings.

There are three levels of financial incentives (gold, gold plus, and platinum), corresponding to increasing levels of green technologies and energy savings obtained. For energy performance, the gold level requires energy efficiency at the level required by the building standard. The gold plus level requires energy performance 25 percent better than standard, while the platinum level requires energy performance 30 percent better than the standard. The incentives range from SGD$3 (around US$2) per square meter to SGD$6 (around US$4) per square meter of gross floor area (GFA) for new buildings; retrofit of existing buildings is eligible for about 40 percent of the incentive for new buildings per square meter.[148] The government is planning to make it mandatory for all new public sector buildings and those undergoing major retrofitting works to receive green mark certification.[149]

Energy Smart Buildings Scheme - Energy Smart Office

This voluntary program aims to promote the active management of energy use. It gives an energy label or "Energy Smart Badge" to high-performance buildings that are among the 25 percent most energy-efficient and meet both energy and indoor environmental quality criteria. Presently, the scheme is ready for office buildings. In late 2005, eight buildings were given energy smart badges.

Energy Audit of Selected Buildings

The BCA has embarked on a program to audit a selected number of buildings with high energy consumption, including large offices, hotels, shopping complexes, hospitals and institutions. It has just completed an exercise to band government buildings based on their energy consumption indices.

Energy Efficiency Index (EEI) and Performance Benchmark

To provide good information about building energy performance and related building energy features so that building owners can estimate the cost-effective potential for building energy savings, the BCA is trying to establish an EEI for all buildings with a sizeable air-conditioning load and to set an energy performance benchmark by building type. Building owners then will know how their building compares to the performance benchmark. To date, a study of data for 104 office buildings has been accomplished; the report is available on the BCA-NUS Building Energy & Research Information Centre web site.[150]

Energy Management of Public Sector Buildings

To provide landlord government agencies a rough indication of how they fare in comparison with other buildings of the same type in terms of energy performance, the BCA is planning to band all public sector buildings by type based on energy performance into three groups, i.e. the top 25 percent, middle 50 percent and bottom 25 percent. An initial banding of all large public office buildings has been completed.

Energy Training Program for Energy-Efficient Building Management

In the fall of 2006, NUS began a program to train building managers how to operate their buildings more efficiently and how to monitor the performance of their buildings in order to know how well (or poorly) their buildings were performing.

Financial Incentives

The Singapore government offers an approved accelerated tax depreciation scheme for (1) replacement machines and equipment and (2) energy-saving equipment and devices. Financial incentives are also provided in an investment allowance scheme (IAS), the local enterprise technical assistance scheme (LETAS), and the energy efficiency improvement assistance scheme (EEIAS).

Performance Contracting

The BCA plans to encourage performance contracting, based upon its successful application in the U.S. and elsewhere, and the BCA plans to work with the Ministry of Finance on a standard form of performance contract for public buildings.[151]

Showcase Buildings

To provide a showpiece of energy-efficiency measures that are viable, the Building Energy & Research Information Centre web site includes a description of a current showcase building, Revenue House, which is owned by the Inland Revenue Authority of Singapore. The building is the first of a new generation of intelligent buildings designed and built by the Public Works Department. It was completed in 1996, and consumes about 30 percent less energy than the average building. The building won the ASEAN Energy Efficiency Award in 2000.[152]

Energy-Saving Guide for Consumers

This guide offers tips and measures that consumers can adopt to reduce energy bills and help preserve our environment.

South Korea

Summary

- South Korea was the 10th largest energy-consuming nation in the world in 2001. Although the industrial sector is the largest energy consumer, energy consumption in the building sector showed higher growth in recent years.
- Since the mid-1990s, the South Korean government has been pursuing a new goal of sustainable development in its national energy policy, taking into consideration such factors as economic growth, environment, and energy security.
- Among the 11 economies reviewed, South Korea formally adopted a building energy standard the most recently, in 2004. However, South Korea has since put in place a comprehensive program to minimize building energy consumption, coupling mandatory standards with voluntary efforts in building energy labeling, a green building certification program, and financial incentive programs.

Data Profile[153]

South Korea is the 11th largest economy and 10th largest energy-consuming nation in the world. From 1980 to 2002, energy consumption in South Korea increased by about 400 percent, with an average annual growth rate of 7.5 percent. Per capita consumption increased about 290 percent during the same period, with a growth rate of 6.4 percent. Estimates show that, from 2002 to 2020, total energy consumption in South Korea will increase more than 60 percent, while per capita consumption will rise around 43 percent.[154]

South Korea has no significant energy sources. It relies heavily on imports to fuel its growing economy. From 1980 to 2004, overseas energy dependency in South Korea grew significantly, from 73.5 percent to about 97 percent.

The industrial sector is the biggest energy consumer, accounting for 55.4 percent of total energy consumption in 2003, with the building and transport sectors trailing at 21.5 percent and 21.1 percent, respectively. In recent years, however, energy consumption in the building and transport sectors has been growing faster than the industrial sector.

Within the building sector specifically, energy consumption of residential buildings grew at an average annual rate of 4.0 percent between 1998 and 2001, while that of commercial buildings increased at a rate of 10.3 percent during the same period.

CO_2 emissions in South Korea increased by more than 330 percent from 1980 to 2002, growing at an average rate of 6.9 percent. With the counter-climate change measures taken by the government, the growth rate of CO_2 emissions in South Korea is expected to slow down significantly, to 1.9 percent between 2002 and 2030.[155]

National Energy Policy

In the wake of the second world oil shock, South Korea immediately established the Ministry of Energy and Resources in 1978 (later incorporated into the Ministry of Commerce, Industry and Energy (MOCIE)) to administer the planning and enforcement of national energy policies.

South Korean energy policy has long focused on increasing the supply of energy to satisfy rapidly growing demand that is the result of strong economic growth over the last 30 years. Due to growing concern about the environment, since the mid-1990s the South Korean government has been pursuing a new goal of sustainable development in its national energy policy. Energy policy focuses on the same 3Es as Japan: Energy Security, Energy Efficiency, and Environmental Protection.

To achieve the 3Es, the South Korean government is pursuing these initiatives:

- Diversifying the supply of energy by promoting greater use of natural gas, encouraging the development of nuclear capacity and initiating steps to launch renewable energy markets.
- Introducing competition and increasing the efficiency of the energy market. The government has begun to withdraw gradually from direct operations in the energy sector through capital ownership, licenses and control, leaving the market free to allocate resources for investment.
- Developing an environment-friendly system by promoting conservation and more efficient use of energy.
- Lowering energy intensity. Compared with the 1990s, investments in energy-intensive industries are expected to fall sharply in the coming years, causing energy intensity to fall from its current levels, particularly as energy prices increasingly reflect full costs.

Energy-Efficiency Policies

The South Korean government views energy conservation and efficiency as one of the essential tools for achieving a sustainable energy supply and demand structure. According to the Second National Energy Plan (2002-2011), rational energy utilization is one of three basic pillars for policy initiatives supporting a sustainable energy policy.

South Korea runs a vigorous energy conservation program. The Rational Energy Utilization Act (REUA) was promulgated in 1979 to serve as a basic law for energy efficiency and conservation. Energy-efficiency programs and activities are planned and implemented based on the REUA by the South Korea Energy Management Corporation (KEMCO), a government agency which was established in 1980. KEMCO functions as the national energy-efficiency center responsible for the implementation of national energy-efficiency and conservation programs.

In South Korea, the Minister of MOCIE is expected every five years to draft a basic plan for the rational use of energy. According to the Second Basic Plan for Rational Energy Utilization (1999-2003), South Korea's energy-efficiency strategies include:

- Establishing a systematic energy-saving structure through identifying energy-saving sectors and facilitating investment in energy efficiency and conservation;
- Promoting voluntary energy savings in the private sector through market-oriented measures (e.g. economic incentives);
- Promoting demand-side management;
- Promoting the use of new and renewable energy; and
- Promoting R&D for fundamental energy-efficiency improvement.

Energy-efficiency policies in South Korea primarily target the industrial sector. From the mid-1970s to the mid-1990s, the South Korean government made a concerted effort to foster energy-intensive industries such as iron and steel, petrochemicals and machinery. This focus has resulted in an industrial sector that consumes more than half of the nation's energy. South Korea has now formulated extensive energy-efficiency programs particularly aimed at these energy-intensive industries.

At the same time, South Korea has applied a number of measures aimed at improving energy efficiency in the transport and building sectors, including energy-efficiency standards and labeling, financial incentives, training and education, energy audits, awareness raising, etc.

Building Energy-Efficiency Policies and Initiatives

Although government-affiliated research institutes, universities, and utility companies have been investigating building energy efficiency since the mid-1980s, South Korea did not formally adopt a building energy standard until 2004. However, despite its recent adoption, South Korea has since put in place a comprehensive program to minimize building energy consumption, coupling mandatory standards with voluntary efforts in building energy labeling, a green building certification program, and financial incentive programs.

Building Energy-Efficiency Standards

South Korea has a mandatory building energy standard that was passed on December 31, 2004 under Notification 2004-459 of the Ministry of Construction and Transportation (MOCT).

Scope

This standard is mandatory for all buildings where high energy consumption is expected.[156] For these buildings, an energy conservation plan must be submitted before construction to show how much of the standard has been incorporated in the building design, and a point total estimated based on the energy-saving plan. All buildings must submit an energy-savings plan with a point total of at least 60 in order to comply.

Contents and Approach

The South Korean building energy standard was developed after a review of standards from several countries, including the U.S., United Kingdom, Germany, Japan, and Canada. Although the developers acknowledged the quality and detail of the more complex standards such as those in the U.S. and Germany, they adopted a simple prescriptive standard, such as that of the United Kingdom and Japan, as the most appropriate and easiest to implement in South Korea.

The standard contains three parts—mechanical, electrical, and architectural—each with mandatory and "encouraged" requirements. The mandatory requirements represent basic responsible design, while the "encouraged" requirements represent more innovative and best-practice strategies.[157]

The use of a point system for compliance effectively turns the South Korean standard into a quasi-performance-based standard. To arrive at the required 60 points for compliance takes more than simply meeting all of the mandatory requirements. The owner must also adopt at least some of the "encouraged" requirements, although their selection and choice are completely at the discretion of the owner. In the design of the point system, MOCT took into consideration not only the energy-saving potential of the "encouraged" measure, but also its ease of adoption in the actual building market. For example, a new technology that has good energy-saving potential but is expensive will be given higher points to encourage its use.[158]

Jurisdiction

The building standard was developed by MOCT, and is administered as part of the building permit process for new buildings. To get a building permit, the building owner must submit an energy conservation plan signed by a licensed architect, a professional mechanical engineer, and an electrical engineer, to the local government office in charge of building regulations. Some local offices review the plan by themselves, but those that lack the expertise can request help from KEMCO. KEMCO provides assistance voluntarily to local authorities, but the final decision and responsibility for approving an energy conservation plan rests with the local authorities. However, KEMCO does have the legal authority to pass energy conservation plans.

Compliance

The MOCT planned to examine and approve 1,450 energy-saving plans in 2005, 2000 in 2006, and 2500 in 2007. However, in actual practice, in the first year (2003-2004), 2,564 energy-saving plans had already been examined. To further improve South Korea's building energy standard, the government asked South Korea Institute of Construction Technologies (KICT) to investigate the status of the current standard and policies, and recommend improvements. This investigation was to be completed in 2006, with the expectation that the scope of the standard would expand to more buildings, and a performance-based energy standard limiting the total energy use per square meter of floor area in new buildings would be developed. However, the Asia Business Council researchers are not aware of any information showing the result of the investigation and consequent government actions. Simultaneously, the government also announced that the insulation standard would be made stricter over time, and extended it from new construction to include existing buildings. Finally, the government is considering requiring that all real estate transactions include an energy-efficiency certificate, with the associated document attached to all sales transactions.

Appliance/Equipment Labeling and Standards

High-Efficiency Equipment Certification Program

Since 1996, South Korea has been implementing a high-efficiency equipment certification program that certifies high-efficiency equipment and provides financial support and tax benefits. By 2001, 22 items had been certified, with plans to increase that number to 41 by 2009. The government provides financial support and tax benefits to companies making products that have been certified as high-efficiency equipment. Products are also conferred the right to use an "e" mark to certify the validity of the high-efficiency equipment. Meanwhile, the government applies an expanded rebate program to all high efficiency equipment items, granting financial support and tax benefits to energy-efficient companies. Regulations mandating the use of high-efficiency equipment are being expanded to cover construction standards to attain improved energy efficiency. Finally, the South Korean government is encouraging public institutions to purchase and install energy-efficient equipment.

Energy-Efficiency Standards (Grades 1-5) and Labels

Mandatory standards and labels have been among the most successful components of South Korea's conservation strategy. Since 1992, efficiency standards (grades 1-5) and labels have been marked on products, including refrigerators and automobiles, which have dramatically increased energy efficiency of common appliances. By 2001, 5,294 models of 11 items were classified and registered, of which 3,849 models were evaluated as high-efficiency products of grades 1 and 2, representing 73 percent of the total number of products. The government plans to add one to two items per year that are subject to its efficiency classification. For example, compact fluorescent lights (CFLs) were added in 2003. The South Korean government is also continuously upgrading the minimum energy performance standard.

Other Initiatives

In addition to the mandatory building standards and appliance standards and labeling, the South Korean government has also established an impressive number of voluntary programs to stimulate building energy efficiency. These include:

Energy-Efficient Labeling Program for Buildings

Under this program, newly built or repaired multi-dwelling units with more than 18 households will be classified into grades 1-3 depending on the use of energy-conserving facilities and equipment throughout the life cycle of the construction project. Buildings that are above a certain performance standard will be given a certificate of building energy efficiency and a construction loan at a lower interest rate. The government is planning to expand this program by targeting detached houses and business buildings.

Green Building Certification Program

This program evaluates the elements affecting the environment throughout the life cycle of the building construction process (production of material, design, construction, maintenance and dismantling of buildings) with the goal of improving the environmental performance of the buildings and reducing greenhouse gas emissions. Under this program, certification audits will be targeted for existing buildings, but if the construction contractor desires an audit from the beginning stage of design, a preliminary certification will be endowed. This system has four grades and certification is valid for five years. An extension may be requested for an additional five years. After 10 years, the regulation requires renewal. This program is currently limited to multi-dwelling units, housing and commercial complexes, businesses (public and private buildings), commerce (schools, hospitals, etc.), and remodeled buildings.

Planned Financial Support

At the same time, KEMCO is planning to provide financial support to energy-efficient activities under Notification No. 2002-239 of the Ministry of Commerce, Industry and Energy (MOCIE). These activities cover co-generation, energy savings, energy service companies (ESCOs), demand forecasting, or use of alternative energy.

Energy Audit Program

Energy audits in South Korea have been conducted mainly by KEMCO. The corporation has different types of energy audit programs for industry and buildings, respectively. In the building sector, energy audits are conducted for large residential and commercial buildings at the request of the owners of those buildings. After auditing, the company identifies and recommends energy-saving measures, such as thermal insulation and double-glazed windows, together with technical assistance. The Minister of MOCIE may order the correction and improvement of energy-loss factors identified by the audit, and low-interest policy funds are available for making the improvements.

Between 1980 and 2001, a total of 377 energy audits were performed on buildings. Between 2002 and 2004, South Korea implemented a Three-year Plan for Energy Auditing and inspected a total of 2,096 businesses and buildings. The government is promoting expansion of this energy audit program.

Voluntary Agreement for Existing Buildings

This joint program between the government and building owners aims to reduce energy consumption and reach greenhouse gas emission reduction targets. It targets owners of buildings who use more than 2,000 tons of oil equivalent (toe) per year. Building owners who intend to join the agreement submit a concrete action plan and specify energy consumption and greenhouse gas emission reduction target (5 percent savings over five years is recommended). Under this program, government provides low-interest loans, tax incentives, technical support and public relations promotion to the building owners.

Energy Savings in Public Organizations

South Korea has an aggressive public sector energy conservation program that encompasses not only its national government, but also city and provincial governments and public corporations. Under this program, public organizations are expected not only to save money but also to inspire citizens to save energy. Both MOCIE and KEMCO carry out the program.

Three programs are particularly notable. The Prior Consultation on Energy Utilization Planning Program, begun in 1993, aims to affect energy-related projects such as the construction of new public buildings. The goal is to influence these projects while they are still in the planning stages. By the end of 2001, the program had influenced 245 projects, promoting the installation of energy-efficient equipment and systems, as well as larger-scale (e.g., cogeneration) and renewable energy installations. Currently, MOCIE and KEMCO are trying to broaden the program's reach through the use of financial incentives and on-site assistance to promote highly energy-efficient design.

The Energy Conservation Guideline for Public Institutions, started in 1997, directs the creation of annual energy conservation plans, including reduction targets, by public organizations. One element is an efficient public building code requiring the installation of energy-efficient systems and equipment in new public buildings.

In the purchasing arena, South Korea maintains an Energy-Saving Product List that includes both products that fall under South Korea's national energy information labeling program, such as clothes washers and cars, as well as energy-consuming products that hold the South Korean endorsement label for being more efficient than others of the same type. In all, 55 product types are covered. Public sector buyers are required to purchase models with the endorsement label, which covers 43 classes of products.

Taiwan

Summary

- Over the past 20 years, Taiwan has substantially revised its national energy policy to find a balance between securing energy supply for its economic growth and strengthening its environmental policies.
- Energy efficiency and conservation is a major component of Taiwan's energy policy, with the building sector one of the six main target sectors. This sector alone is expected to contribute 8.7 percent of the total 28 percent energy-saving goal for 2020.
- Taiwan is among the leading economies in Asia in terms of the comprehensiveness and depth of building energy-efficiency standards. The standards are now well accepted as basic building requirements in Taiwan, with rigorous voluntary programs going beyond the baseline.

Data Profile

Taiwan's vibrant economic growth relies on a steady supply of energy. Statistics show that energy consumption in Taiwan increased by over 200 percent during the 20 years from 1984 to 2004, with an average annual growth rate of 6.0 percent. Per capita energy consumption increased by around 170 percent during the same period, with an annual average growth rate of 5.0 percent.[159] According to APEC's prediction, total final energy consumption will rise more than 75 percent from 2002 to 2020, while per capita consumption will rise 54 percent during the same period.[160]

With the evolution of its economy, there is a slight change in Taiwan's energy consumption structure. The industrial sector is still the biggest consumer of energy, although its share of total energy consumption dropped from 60 percent of the total to 57 percent from 1984 to 2004. The building sector (residential and commercial), which accounted for 14 percent of total consumption in 1984, became the second largest sector, taking 18 percent of the total in 2004.[161] Energy consumption of the building sector rose two-and-a-half times from 1980 to 2002, while per capita consumption within the sector rose around 170 percent. It is predicted that from 2002 to 2020, energy consumption of the building sector will rise by 70 percent, and per capita consumption will rise by about 60 percent.[162]

Because Taiwan has a subtropical climate, nearly every building in Taiwan is equipped with an air conditioner, or a central air conditioning system. On a daily basis, the air conditioning load accounts for around 40 percent of the energy consumed in a typical building, while lighting accounts for another 35 percent. The cooling load is the main cause for summer peak power demand that is almost 1.4 times that of winter, sometimes causing power shortages.

The annual CO_2 emissions per capita in Taiwan are estimated to have been increasing at a rate of 7.5 percent. If Taiwan were to reduce its greenhouse gas emissions to 1990 levels by the year 2010, it would have to reduce the projected 2010 emissions by more than half.

Energy Policy

Taiwan is a densely populated island with only limited natural resources, relying heavily on imports in energy supply. Domestic energy production accounted for 10.8 percent of the total energy demand in 1984, but it dropped rapidly to only 1.8 percent in 2004. With growing energy use in Taiwan, securing energy supply is becoming increasingly difficult.

The first version of "The Energy Policy of the Taiwan Area" was promulgated in April 1973. Afterwards, in response to the impact of energy crises and changes in the local and international energy situation, the energy policy was revised in 1979, 1984, 1990, and 1996.

Revisions in Taiwan's energy policy show that Taiwan has been trying to find a balance between securing energy supply for its economic growth and strengthening its environmental policies.

In the 1970s and 1980s, the government focused primarily on securing a steady supply of energy resources and on accumulating reserves in order to prepare for global price fluctuations and energy crises. However, since the 1990s, environmental factors have featured more prominently in Taiwan's energy policy. Specifically, in 1996, the government announced its determination to establish a clean, efficient and liberalized energy-supply-and-demand system.

The aims of the current energy policy (last revised in 1996) are to establish a liberalized, orderly, efficient, and clean energy system based on the environment, local characteristics, future prospects, public acceptability, and practicability. Taiwan has set a goal of 28 percent energy savings of total consumption by 2020. The building sector alone is expected to contribute 8.7 percent of the total savings.

In responding to the new energy policy, the government encourages public and private industries to improve energy efficiency, restructuring their manufacturing processes to reduce emissions.[163]

Energy-Efficiency Policies

Energy efficiency and conservation is a major component of Taiwan's energy policy. The aim is to combine the efforts of the government and the private sector to meet the international trend of reducing greenhouse gas emissions.

Energy conservation policy in Taiwan targets six sectors: industry, transportation, residential and commercial building, power, education and guidance, and promotion of the development of the energy-saving equipment industry.

As the greatest energy consumer, the industrial sector is Taiwan's energy-efficiency policy priority. However, awareness of building energy efficiency has grown rapidly in Taiwan, and the residential and commercial sector has become an indispensable segment of its energy-efficiency policy. Specifically, the government identified six measures to improve energy efficiency in the residential and commercial sector:

- Form an energy conservation service group for business and government organizations to strengthen technical services;
- Promote civil energy technology services;
- Strengthen the building envelope energy consumption index and expand the implementation of environmental architecture;
- Implement energy-saving measures in the government sector;
- Establish standards for energy-saving designs of air conditioners and illumination in buildings; and
- Popularize energy-saving applications in buildings and provide demonstrations of these applications.

Building Energy-Efficiency Policies and Initiatives

Taiwan adopted building energy standards for air-conditioned, non-residential buildings in 1995 and for residential buildings in 1997. These are mandatory standards that are being rigorously implemented, with demonstrated compliance needed in order for a building permit to be granted. At present, the standards cover only the performance of the building envelope, although for the non-residential standard, energy performance criteria for the HVAC and lighting systems have also been proposed. In addition to the mandatory building energy standard, Taiwan has also been working towards voluntary building energy-efficiency programs such as building energy labeling, a very successful green building certification program, as well as demand-side management (DSM) programs.

Building Energy-Efficiency Standards

There are two building energy-efficiency standards, one developed in 1995 for air-conditioned, non-residential buildings, and another in

1997 for residential buildings. These have been adopted at the national level and are mandatory for the building types to which they apply (offices, commercial buildings, hotels, and hospitals for the non-residential, housing for the residential standard). The compliance of the standards is estimated at over 80 percent, with compliance needed for a building permit to be granted.

The Taiwan non-residential building energy standard is a simplified performance standard that covers only the energy performance of the building envelope. Instead of prescribing the levels of wall and roof insulation, or the thermal and optical properties of the windows, the standard simply sets maximum allowable loads for the building envelope. Minimum allowable efficiencies for the HVAC and lighting system have also been proposed, but these have yet to be implemented. The concept of separating building energy performance into two parts—the building envelope for the perimeter, and HVAC system efficiency for the interior zones—is very similar to the PAL (Perimeter Annual Load) and CEC (Coefficient of Energy Consumption) methods used in the Japan building energy standard. The Taiwan residential building energy standard was adopted in 1997 and is a prescriptive code. The standard has been approved at a national level, but there are regional variations.

The government institutions responsible for building energy efficiency in Taiwan are the Bureau of Energy, Construction and Planning Agency of the Ministry of the Interior, the Architecture and Building Research Institute, and the Environmental Protection Administration. The building energy-efficiency standards were developed by the Bureau of Energy and the Architecture and Building Research Institute, in collaboration with several universities in Taiwan. The standards have become a part of the building permit process for new buildings, which is under the jurisdiction of the Construction and Planning Agency. To get a building permit, the building owner must submit documentation showing that the proposed building design meets the mandatory requirements set forth in the standards. Failure to do so will result in denial of the building permit. It is estimated that, as of 2006, over 80 percent of new construction complies with the standards.

Appliance/Equipment Labeling and Standards

Household appliance energy standards have been established for 12 types of products in Taiwan. The regulation is mandatory, with manufacturers forced to comply to sell their products. At the same time, a voluntary comparison energy labeling program is under consideration.

Other Initiatives

In addition to the mandatory building energy standard, Taiwan has also developed voluntary building energy-efficiency programs, such as a very successful green building certification program called the Green Building Evaluation System, a building energy labeling program, and demonstration and education programs.

Green Building Programs

In 1999, the Architecture Research Institute of the Ministry of the Interior developed a green building evaluation system, called EEWH (Ecology, Energy, Waste and Healthy) that is a special chapter in Taiwan's national building code. EEWH evaluates buildings based on nine indicators, including biodiversity, green landscaping, site water conservation, CO_2 emissions reduction, waste reduction, indoor environment, water resources, sewage and garbage treatment, as well as energy conservation. This system has been simplified and localized for the subtropical climate of Taiwan.[164]

EEWH targets newly-built buildings and issues two types of certification to buildings, the Green Building Label and Green Building Candidate Certification. It is a voluntary program but is mandatory for any new public building construction project funded by the government that exceeds US$1.5 million. According to some experts, EEWH has been very successful and in many ways has taken the public spotlight from the building energy-efficiency standards.

With the evaluation mechanism provided by EEWH, the Green Building Promotion Program of Taiwan was proposed in March 2001 and first revised in May 2003. The program forges a comprehensive mechanism providing resources, research, guidance, training, and education to support the adoption of green building in Taiwan. One of the major promotional strategies of this program is to initiate green building design for all public buildings. Mandatory Green Building Label based on EEWH for all new official buildings of the central government was required beginning in 2002 and for local government buildings starting in 2003. To date, Taiwan has more than 500 buildings certified as green building or green building candidates. Furthermore, the government also subsidizes green retrofitting projects for existing buildings. The green retrofitting projects employ a variety of green building technologies, including insulation improvement work such as the installation of sun shading devices, and ecological protection work such as constructed wetlands combined with the function of wastewater treatment and reuse. From 2002 to 2003, 28 green retrofitting projects were completed for official buildings and public schools. The green building policy can be viewed as successful in the public sector.

In 2005, the Taiwan Green Building Council, initiated by the Architecture and Building Research Institute (ABRI), was officially launched. The mission statement of the Taiwan Green Building Council focuses on the development in the construction industry, including: promoting green buildings, facilitating international cooperation, and assisting in the globalization of Taiwan's construction industry.

Building Energy Labeling

The Bureau of Energy has launched an Energy Labeling Program for appliances/equipment and many types of buildings and has also announced a voluntary energy benchmark for buildings.[165] However, the energy labeling program for buildings is not yet implemented

Demand-Side Management Programs

These programs are being promoted by the Bureau of Energy in conjunction with the Taiwan Power Company.[166]

Incentive Programs

Solar hot water systems have been promoted since 1986. Every square meter of solar collection qualifies for a US$66 cash rebate from a governmental incentive program. In 2000, the accumulated solar collection area exceeded one million square meters and the program was halted. However, in 2003, because of the program's significant energy savings, it was restarted.

Demonstration and Educational Programs

The Energy Commission under the Ministry of Economic Affairs in Taiwan has established web sites to promote the concept of energy savings by displaying data on demonstration projects and disseminating pamphlets and notes. The National Science and Technology Museum is displaying demonstration systems on a year-round basis to educate citizens.[167]

Thailand

Summary

- Thailand's energy policies mainly aim to reduce dependency on energy sources from foreign countries, with emphasis on conserving and developing energy resources, as well as promoting the efficient use of energy.
- The energy-efficiency and conservation program in Thailand, targeting mainly the industrial and building sectors, is one of the most advanced in ASEAN.
- In Thailand, compliance with building energy-efficiency codes has been mandated, with significant energy savings in some areas, but evaluation, monitoring and documentation are still weak.
- Thailand is the leader among ASEAN countries in establishing and implementing demand-side management (DSM) program. Its comprehensive, nation-wide demand-side management program covers appliance/equipment energy labeling, building energy efficiency, consumer education, etc, and has been successful in achieving overall energy reduction goals.

Data Profile[168]

Thailand's energy consumption soared over 250 percent from 1980 to 2002, with an average annual growth rate of 6.0 percent. Per capita energy consumption increased by more than 140 percent over the same period, with an annual average growth rate of 4.1 percent. Energy consumption is expected to continue rising at this rapid pace, with Thailand's final energy consumption increasing more than 150 percent from 2002 to 2020, while per capita consumption is expected to rise by around 130 percent during the same period.

Breaking consumption down by sectors, the building and industrial sectors have used 20 percent and 45 percent of the total energy consumed in recent years, respectively. These two sectors share 95 percent of the nation's electricity consumption. From 2002 to 2020, energy consumption of the building sector is projected to grow by 80 percent, and per capita consumption to rise by more than 60 percent.

In a typical commercial building in Thailand, the air conditioning load accounts for between 45 and 50 percent of the energy consumed, while lighting accounts for another 30 percent. For a typical residential building, lighting and air conditioning contribute some 30 percent of total energy consumption.[169]

Associated with this increase in energy use, CO_2 emissions in Thailand rose at an average annual rate of 8.0 percent from 1980 to 2002, and are estimated to increase at a rate of 4.9 percent from 2002 to 2030, both numbers being the highest among the 11 Asian economies reviewed in this study.

National Energy Policy

While energy demand has risen sharply, domestic sources of supply are limited, and imported energy exceeds 60 percent of total energy demand. With Thailand's predicted high economic growth, energy security will be a continuing challenge.

In the 1980s, with the rapid growth in energy demand, the primary objective of national energy policy was to procure sufficient energy to meet increasing demand. This was done mainly through investments on the supply side: power generation, transmission and distribution systems, oil refining and marketing as well as natural gas production and pipeline network.

Since the early 1990s, Thailand has begun to emphasize both the supply and demand sides, and both energy security and environmental protection. The 2002 Thai national energy policy emphasizes conserving and developing energy as well as promoting the efficient use of energy in balance with the country's environment and natural resources. While enhancing national energy security and reducing dependency on energy sources from foreign countries is still the primary objective, the government is proactively promoting efficient and economical use of energy and the use of renewable energy sources to reduce total energy demand and protect the environment.

In 2005, with a view toward reducing dependency on imported energy and strengthening energy supply security, the Thai government formulated the National Energy Strategy, which calls for reducing energy consumption by 13 percent and 20 percent in 2008 and 2009, respectively. Under this strategy, finding alternative energy and devising new technologies for energy efficiency and conservation are top priorities in the energy master plan.

Energy-Efficiency Policies

In 1992 the government launched the Energy Conservation Act (the ENCON Act), which has been the primary legislation guiding Thailand's energy-efficiency and conservation policy.

The ENCON Act, made effective in 1995 via a Ministerial Order, aims to promote energy conservation and to encourage conservation investments in factories and buildings. It includes mandatory regulations plus incentives to facilitate the implementation of the required energy-efficiency measures. It also includes an Energy Conservation Fund (ECF) that started with US$60 million and receives some US$57 million annually to provide working capital, grants and subsidies to promote energy conservation. Main contents of the ENCON Act include:

- A compulsory program for designated facilities that comprise approximately 4,500 large commercial and industrial facilities (buildings and factories);[170]
- A voluntary program for smaller facilities, primarily small and medium-sized enterprises (SMEs), that includes demonstration

and pilot projects, research and development, renewable energy, information campaigns, and other special projects; and

- A complementary program of public relations, human resource development, and administration of ENCON, as well as the monitoring of implementation of the funds allocated for program activities.

Building Energy-Efficiency Policies

Building Energy-Efficiency Code

First Version of the Code

The first-generation Thai energy code was first endorsed in 1995 as a set of building energy codes for designated buildings and government buildings and was further defined that same year as a Ministerial Regulation as part of the ENCON Act.

The energy code has been mandatory since 1995 for both existing and new buildings. A primary focus has been on mandatory enforcement for existing "designated buildings" as well as new "designated buildings" constructed after the enactment of the ministerial regulation in 1995.[171] The capacity and consumption limits used to define "designated" buildings indicate that most of these buildings have air-conditioned floor areas greater than about 10,000 square meters.

Energy audits were required for existing designated buildings, and several thousand reasonably detailed audits of existing buildings have been done. The conduct of such a large number of building energy audits was a major energy code implementation undertaking and is unparalleled in the Southeast Asia region, perhaps with the exception of Singapore. This mandate has spawned the development of a Thai energy auditing industry, and has also produced a valuable database of energy characteristics of larger Thai buildings.

In reviewing summary data from the many audits conducted, Asia Business Council researchers noted that many existing buildings apparently complied with the energy code requirements (about 60 percent met the envelope requirements,[172] 75 percent met the lighting requirements,[173] and close to 50 percent met the air conditioning requirements). Still, a substantial number of existing buildings did not comply with the building energy code requirements (about 40 percent for the building envelope, 25 percent for lighting, and over 50 percent for air conditioning).

The ENCON Act also requires that designated buildings that do not meet the code requirements undergo retrofit changes to comply with the requirements. For those designated buildings that do not, registered consultants prepare targets and plans that project owners agree to in writing. These plans are then submitted to the authorities and owners are obliged to follow the compliance plans for their buildings. A number of designated buildings received such retrofits for at least some systems, mainly the lighting system. For example, of some 2000 audits that have been analyzed, the required plans to retrofit the buildings' lighting systems to bring them into code compliance were actually accomplished. Thus, the ENCON Act has clearly had an impact, although not impressive. However, because of the poor organization and accessibility of the auditing data and weak follow-up monitoring and evaluation, it is not clear how many retrofits have occurred for the air conditioning and building envelope systems or how much energy has been saved as a result. This is unfortunate, since these systems can account for 50 percent or more of total building energy use under Thai climate conditions. The Thai data on the air conditioning and building envelope retrofits done for the ENCON compulsory program is a potentially valuable but untapped resource about building energy efficiency both in Thailand and in the region.

For new buildings, additions, or renovations, a key infrastructure issue exists. The individuals currently responsible for checking the energy code compliance are the staff of the technical departments in local building department administrations that issue building permits. However, there are few, if any, local staff skilled or trained in evaluating the energy issues or energy compliance. Also, apparently, there are no detailed compliance forms or requirements to submit. Building owners and designers are knowledgeable about the general energy code requirements, but when an application for a building permit is submitted, it includes a general statement that the building complies with the energy code without any detailed justification. This could be because it is not required or because the staff at the technical department at the local authorities do not have the required skills to perform a proper check of the documentation.[174]

Planned Revisions to the Energy Code

In the past five years, the Thai government has developed a revised energy code based on substantial revisions. The original approach had been to identify prescriptive requirements for the thermal performance of building envelope, the efficiency of cooling/heating systems and maximum lighting wattage per square meter. The latest code revisions retain the prescriptive compliance approaches, but place more emphasis on compliance that assesses the energy performance of major building systems (envelope, lighting, air conditioning) or of the energy performance of the whole building. Some aspects of the new Thai code formats are quite innovative, such as the equations used for assessing the performance of the air conditioning systems. In terms of savings targets, the new code requirements will produce an estimated extra energy savings of 8-9 percent as compared with the current energy code. At the time of this writing, the new draft codes were being prepared to be submitted to the Thai cabinet for endorsement. The administration and enforcement procedures for these new codes are not clear at this time.[175]

Jurisdiction

Energy has become such an important issue to Thailand that a new Ministry for Energy was formed in 2002. Several primary government agencies are responsible for energy-efficiency activities under the Ministry of Energy.

- The Department of Alternative Energy Development and Efficiency (DEDE) is the primary government agency that formulates and determines building energy code requirements.
- The Department of Public Works and Town & Country Planning under the Ministry of Interior administer and enforce the building energy codes.
- The Energy Policy and Planning Office (EPPO) formulates energy policy, as well as strategic policy for energy efficiency and renewable energy.
- The Electricity Generating Authority of Thailand (EGAT) is a state-owned electricity generating company that has been managing a demand-side management (DSM) program in Thailand since the mid-1990s.

There has evidently been an effective, long-term collaboration between government and academia in Thailand that has contributed to the development and refinement of building-energy standards. This cooperation has included various pilot training programs in the past that were implemented over time via government cooperation with various Thai academic institutions.

Appliance/Equipment Labeling and Standards

Energy Labeling

Thailand has been implementing energy labeling programs on a mostly voluntary basis since 1994 when the Electricity Generating Authority of Thailand (EGAT) began a voluntary energy-labeling program for household refrigerators, which is part of Thai's nation-wide demand-side management (DSM) program. In the following years, EGAT launched labeling programs for a number of products such as air conditioners, ballasts, electric fans, fluorescent lamps, rice cookers, and the like. The original savings target of this program set in the Five-Year Master Plan was 238 MW. By June 2000, after less than six years of implementation, EGAT had exceeded this five-year peak target by 138 percent (566 MW) and by June 2001, it had exceeded the target by 168 percent (638 MW). A significant and growing portion of these program savings were due to the energy labeling programs for refrigerators and air conditioners.

Minimum Energy-Performance Standards

Development of minimum energy performance standards has lagged behind implementation of energy labeling. Under the direction of the National Energy Policy Office, a study was carried out in 1999 on the introduction of minimum energy-performance standards for five classes of products: compact fluorescent lamps; fluorescent lamp ballasts; refrigerators; air conditioners; and electric motors. These standards were to begin taking effect in 2003 and 2004. Implementation has been delayed, however, and the first standard began to take effect on a voluntary basis for refrigerators and air conditioners only in 2005.

Other Initiatives

Demand-Side Management (DSM) Program

Following the enactment of the ENCON Act in 1992, the Electricity Generating Authority of Thailand (EGAT) established a large nationwide demand-side management program in 1993, starting with the implementation of appliance energy labeling. This US$189 million program was funded mostly by Thailand (79 percent) with an automatic fuel tariff while three international sources together contributed 21 percent (the Global Environmental Facility (GEF), Australia, and Japan). EGAT created a Demand-Side Management Office (DSMO) that grew to 177 people by 2000 and implemented a broad range of demand-side management programs for three sectors: commercial, residential, and industry.[176]

In late 1995, the demand-side management program expanded to include energy efficiency in existing commercial buildings. The

DSMO offered energy audits and investment consultation for high-return energy measures of building lighting, cooling, envelope and load management systems.[177] This program has been coordinated with the compulsory program conducted under the ENCON Act. By 2000, 433 owners/managers had applied to participate, and 252 preliminary audits had been conducted. But only 34 had been approved because of a backlog of audits under review within the government agency responsible for the compulsory audits. Other issues included (1) a lack of secure funding sources for energy measures to be implemented, and (2) the need to improve coordination between the DSMO and the agency responsible for the compulsory audit program.

During the 1996-1998 period, EGAT began a major expansion of its demand-side management program and launched about 15 new programs. The programs most germane to buildings are listed below:

- CFLs: Labeling, testing and promotion of compact fluorescent lamps (CFLs);
- Low-loss ballasts: Promotion of low-loss magnetic ballasts;
- Green leaf: Audits and certification of energy-efficient hotels;
- New commercial buildings: analysis of viability of energy measures and support for installation of measures that exceed code requirements;
- Small and medium enterprises (SMEs): promote predefined energy measures in SME premises, including ECF financing;
- Load management: DSMO support to another agency responsible to promote load management;
- Thermal storage: construction of demonstration facility; and
- Attitude creation: portfolio of publicity campaigns.

The first two programs might be categorized as labeling programs, while the other programs represent a diverse portfolio of demand-side management actions.

EGAT is now preparing to issue, by the end of 2007, new, more stringent labeling standards for electrical products, beginning with air conditioners because they account for the largest portion of residential electricity bills.

In general, EGAT's demand-side management programs have achieved its overall peak and energy reduction goals.[178]

Energy Conservation Fund (ENCON Fund)

In conjunction with the legislation of the ENCON Act, the ENCON Fund was established to provide financial support to government agencies, state enterprises, non-government organizations, individuals and businesses that wish to follow the act by implementing measures to increase efficiency in energy utilization. The ENCON Fund receives revenues from a tax of THB$0.04 (US$0.001) per liter on all petroleum products sold in Thailand. The tax provides annual inflows of approximately THB$2 billion (US$50 million) per year. In June 2005, the ENCON Fund had a balance of more than THB$14 billion (US$350 million). The allocation of money from the ENCON Fund to activities that support energy efficiency and renewable energy is an important government priority.

To date, the ENCON Fund has funded 10 building projects and 56 factory projects. Results so far indicate that each dollar of lending results in more than 10 dollars in lifetime energy cost savings, and that every dollar lent from the fund leverages approximately 60 cents additional in commercial bank lending.[179]

Energy Efficient Building Award

The Department of Energy in Thailand has recently begun to provide awards to energy-efficient buildings, and the first round of awards was announced in 2006. In the Designated Building category, the Tesco-Lotus department store, Ratanathibet branch, received an energy award. Two buildings also received awards in the category of Creative Building for Energy Conservation: Tesco-Lotus at Rama 1 branch won for a new building; and the North NaNa branch of the Krungthai

Bank won for a retrofit of an existing building.[180]

Green Building Program

Green building activities for commercial and institutional buildings seem to be still in the early stages in Thailand. EGAT has had a green building program, but it evidently targeted a limited number of buildings and its effectiveness is not known. A Thai bio-solar house was featured as a case study in 2003 in *Architecture Week*.[181]

Regional Energy-Efficiency Activities

Thailand has actively participated in ASEAN regional energy-efficiency activities, including participation in the development of regional energy benchmarking of buildings and regional energy-efficient building award programs.[182]

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[22] The 16 cities include Bangkok, Berlin, Chicago, Houston, Johannesburg, Karachi, London, Melbourne, Mexico City, Mumbai, New York, Rome, São Paulo, Seoul, Tokyo, and Toronto. See "Landmark Program to Reduce Energy Use in Buildings", the Clinton Foundation, see: http://www.clintonfoundation.org/051607-nr-cf-fe-cci-extreme-makeover-green-edition.htm

[23] The United Kingdom government in December 2006 issued a consultation document, "Building a Greener Future: Towards Zero Carbon Development", seeking views on the government's proposal for moving toward zero carbon homes, under which all new homes in England will have to be carbon neutral by 2016. The proposal includes tightening building and planning rules, and a star rating system that reveals a property's energy efficiency to potential home buyers. After the consultation exercise closed in March 2007, a "2016 Taskforce" headed by Minister for Housing and Planning and Minister for Communities and Local Government was set up to identify barriers to the implementation of the 2016 zero-carbon target, and put in place measures to address them. See web site of Department of Communities and Local Government, the United Kingdom Government, http://www.communities.gov.uk

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[34] Northwest Energy Efficiency Alliance, 2002, "Building Commissioning Overview for Design Professionals", Betterbricks Project, Northwest Energy Efficiency Alliance, see: http://www.betterbricks.com/default.aspx?pid=article&articleid=84&typeid=10&topicname=commissioning&indextype=topic

[35] ABC Interview with Robert Allender, Managing Director, Energy Resources Management, July 3, 2006, Hong Kong.

[36] U.S. Department of Energy, 2007, "Operations and Maintenance", Energy Efficiency and Renewable Energy, Federal Energy Management Program, see: http://www1.eere.energy.gov/femp/operations_maintenance/index.html

[37] Excerpt from presentation given at conference: "The Business Case for Energy Efficiency", May 24, Hong Kong.

[38] TIAX LLC, 2005, "Energy Impact of Commercial Building Controls and Performance Diagnostics: Market Characterization, Energy Impact of Building Faults and Energy Savings Potential", Report prepared for Building Technologies Program of the U.S Department of Energy, see: http://www.tiaxllc.com/aboutus/pdfs/energy_imp_comm_bldg_cntrls_perf_diag_110105.pdf

[39] "Leaky Ducts Are Costing You Money", Marketing template of Carrier, a multinational company providing air-conditioning, heating and refrigeration products and services, see: http://www.xpedio.carrier.com/idc/groups/public/documents/marketing/808-352.pdf?SMSESSION=NO

[40] Lew Siew Eang, "Energy Efficiency of Office Buildings in Singapore", Department of Building, School of Design and Environment, National University of Singapore, see: http://www.bdg.nus.edu.sg/BuildingEnergy/publication/papers/paper4.html

[41] "The 2005-2006 Annual Business Survey", 2006, *Building Services Professional*, An IMC Media Limited Publication, p. 22.

[42] International Energy Agency, 2006, *Light's Labor's Lost: Policies for Energy-efficient Lighting,* Paris.

[43] International Energy Agency, 2006, *Light's Labor's Lost: Policies for Energy-efficient Lighting,* Paris.

[44] HOK, "HOK Sustainable Design Approach", Unpublished report of HOK (an architecture, engineering, interiors and planning firm).

[45] The US Department of Energy, 2007, "Life-Cycle Cost Analysis", June, see: http://www1.eere.energy.gov/femp/program/lifecycle.html

[46] "From Little Things, Big Things Grow", 2005, *Building Services Professional*, February, pp. 26-31.

[47] Diana Farrell, Scott S. Nyquist, and Matthew C. Rogers, 2007, "Making the Most of the World's Energy Resources", *The McKinsey Quarterly*, Number 1, pp.21-33.

[48] Paul Waide, 2003, "Regulatory Framework for Standards and Labeling: International Experience", PowerPoint Presentation presented at conference: "Effective Development & Harmonization of Standards & Labeling Programs in South Asia", October 27-31, Bangalore, India.

[49] Peter du Pont, 2001, "Learning by Doing: The Wealth of Experience Implementing Standards and Labeling Programs in Asia", PowerPoint Presentation presented at the CLASP Regional Conference: "Lessons Learned in Asia: Regional Symposium on Energy Efficiency Standards and Labeling", May 29, Bangkok, Thailand.

[50] Collaborative Labeling and Appliance Standards Program, "General Information on Standard and Labeling", see: http://www.clasponline.org/resource.php?nnx=1&no=10

[51] Paul Waide, 2003, "Regulatory Framework for Standards and Labeling: International Experience", PowerPoint Presentation presented at the Effective Development & Harmonization of Standards & Labeling Programs in South Asia, October 27-31 2003, Bangalore, India.

[52] Kristina Egan, 1999, "Energy Efficiency Standards for Electrical Appliances: Regulatory and Voluntary Approaches in the Philippines and Thailand", *Energy Efficiency: Compendium of Energy Conservation Legislation in Countries of the Asia and Pacific Region*, United Nations, New York.

[53] Diana Farrell, Scott S. Nyquist, and Matthew C. Rogers, 2007, "Making the Most of the World's Energy Resources", *The McKinsey Quarterly*, Number 1, pp.21-33.

[54] David Goldstein, 2006, "Best practice in building codes", PowerPoint Presentation presented in conference: "Energy Efficiency in Buildings: Meeting the G8 Gleneagles Challenge", November 27-28, International Energy Agency, Paris.

[55] J. Deringer, "Introduction to Compliance With ASHRAE Standard 90.1 – 1999/2001", slide #21, PowerPoint Presentation presented at workshop:

"ASHRAE Professional Development Series (PDS): ASHRAE Standard 90.1".

[56] Audrey Chang, 2006, "California's Sustainable Energy Policies Provide a Model for the Nation", March, Natural Resources Defense Council, see: http://docs.nrdc.org/air/air_06033101a.pdf

[57] John Duffy, 1996, "Energy Labeling, Standards, and Building Codes: A Global Survey and Assessment for Selected Developing Countries", International Institute for Energy Conservation, Washington, D.C.

[58] McKinsey Global Institute, 2006, "Productivity of Growing Global Energy Demand: A Microeconomic Perspective", November, see http://www.mckinsey.com/mgi

[59] Huang noted that building energy-efficiency standards are even different between developed countries. For example, Germany's standards are much more stringent than those of the U.S., even for the same climate. On the other hand, the U.S. standards for hot locations give much more consideration to shading than standards in any European country. He thinks that there's no such thing as a "global benchmark", nor should there be. The most important thing for standard-making is that the standards must make technical and economic sense. For example, before requiring triple-pane windows in the standards, one has to make sure that such windows are available on the market and are not cost prohibitive. E-mail correspondence with Huang on June 21, 2006.

[60] David Askew, 1994, "Planning Today for Tomorrow's Future, An Energy Strategy for British Columbia", British Columbia Energy Council, see: http://www.utoronto.ca/env/papers/askewd/strategy.htm

[61] The U.S. Department of Energy, "Energy Codes and Standards", see: http://www.eere.energy.gov/states/alternatives/codes_standards.cfm

[62] World Energy Council, 2001, "Energy Efficiency Policies and Indicators – WEC Report 2001", see: http://www.worldenergy.org/wec-geis/global/downloads/eepi2.pdf

[63] For example, interview with Dr. Sam C. M. Hui, Teaching Consultant, Department of Mechanical Engineering, The University of Hong Kong,

April 21, 2006, Hong Kong; Interview with Dr. Ning Yu, President of (Taiwan) Environment and Development Foundation, June 7, 2006, Hong Kong; Interview with Wang Wei, Deputy Director, Shanghai Research Institute of Building Science, June 7, 2006, Hong Kong.

64 One should rate the energy performance of buildings in order to label them. Therefore, energy labeling programs indispensably involves building energy rating schemes.

65 David B. Goldstein, 2005, "Best Practice for Energy Efficiency Incentives and Their Role in Energy Policy: A Report to the China Sustainable Energy Program for Decisionmakers in China", Natural Resource Defense Council; and David B. Goldstein, 2001, "A comprehensive approach to improve the efficiency of buildings through standards, utility-based programs, tax incentives, and energy ratings", PowerPoint Presentation presented to the China Sustainable Energy Program Policy Advisory Council, November 8, Shanghai, China.

66 World Energy Council, "Energy Efficiency Policies and Indicators", see: http://www.worldenergy.org/wec-eis/publications/reports/eepi/policy_evaluation/incentives.asp

67 Richard G. Newell, Adam B. Jaffe, and Robert N. Stavins, 1999, "The induced innovation hypothesis and energy-saving technological change", *The Quarterly Journal of Economics*, Vol. 114, Issue 3, pp. 941–975.

68 Martine Fackler, 2007, "Japan Offers a Lesson in Using Technology to Reduce Energy Consumption", *The New York Times,* January 6.

69 Northeast Sustainable Energy Association, "Building Energy 07", see: http://buildingenergy.nesea.org/welcome.php; Ralph Cavanagh, "Energy Efficiency in Buildings and Equipment: Remedies for Pervasive Market Failures", U.S. National Commission on Energy Policy, see: http://www.energycommission.org/site/page.php?index

70 See web site of European Commission: http://ec.europa.eu/energy/demand/legislation/buildings_en.htm

71 Morgan Bazilian, 2006, "Energy Security Code of Conduct", Renewable Energy and Energy Efficiency Partnership, see: http://www.reeep.org/

index.cfm?articleid=1484

72 World Business Council on Sustainable Development, 2006, "Energy use in buildings, Energy-Efficient Building Project, Energy Workstream", December 18, unpublished manuscript, p. 15.

73 Diana Farrell, Scott Nyquist, and Matthew Rogers, 2007, "Making the Most of the World's Energy Resources", *McKinsey Quarterly,* Number 1, p. 23.

74 North American Operations, "Ice Chiller Thermal Storage Product Benefits", see: http://www.baltaircoil.com/english/products/ice/tsum/tsum_benefits.html

75 Feng Jianhua, "Construction Challenge", *Beijing Review*, see: http://www.bjreview.com.cn/06-05-e/bus-1.htm

76 China CSR, 2006, "Chinese Government Voices Support For Energy-Efficient Buildings", February 21, see: http://www.chinacsr.com/2006/02/21/chinese-government-voices-support-for-energy-efficient-buildings/

77 Brian Libby, "Is China Ready to Embrace Sustainability?", *Sustainable Metropolis*, see: http://www.metropolismag.com/cda/story.php?artid=1055

78 Zijun Li, 2005, "China Aims to Build Energy-Efficient Society in Next Five Years", *China Watch*, October 20, see: http://www.worldwatch.org/features/chinawatch/stories/20051020-2

79 This means the structures of the industry, products and energy consumption all need to be upgraded with more advanced technologies. This underpins the significance of the development of the tertiary and hi-tech industries.

80 Further reform is believed to be in the right direction toward a well-functioning market where enterprises are the main players. In this process, the government must always be there to navigate the economy. Laws and policies will need to be worked out to serve as incentives to curb the businesses, buildings and products that come with heavy energy consumption and poor efficiency.

81 Qiu Baoxing (vice minister of the Ministry of Construction, People's Republic of China), "China to see green, energy-saving building boom in coming 15 years", 2005, *People's Daily*, February 24.

[82] Interview with Wang Wei, Deputy Director of Shanghai Research Institute of Building Science, June 2006, Hong Kong.

[83] For example, prior to the completion of the HSCW residential standard, Chongqing in 1999 and Wuhan in 2000 had both developed their own local codes. Similarly, Shanghai completed a public building standard in 2003 that was incorporated later into the national standard. In 2005, Beijing revised its residential building energy standard (DBJ 11-602-2006) to be more stringent (65 percent savings) than that of the national standards.

[84] Lighting energy savings are covered by a separate MOC standard, but the savings are included in arriving at the 50 percent total energy savings for the public building energy standard.

[85] The equipment portion of the residential standard contains many requirements regarding the efficient design of the heating system, which in north China is typically a central two-pipe hot water system served by a large boiler. The standard stipulates minimum boiler efficiencies, pipe insulation levels, and individual controls. A major problem in the traditional heating systems in north China has been the absence of controls. For the cooling systems, which typically are individual through-the-wall split systems, or individually installed heating systems, the residential standard stipulates that they must meet a certain grade level of China's energy-efficiency rating system for air conditioners or heat pumps. On a practical level, such requirements are impossible to enforce because in China space-conditioning systems are regarded like appliances and installed by the owner after purchase. The equipment portion of the public building standard is similar to that of the residential standard, except that the prevalence of central air-conditioning systems allows for more focus on efficient design principles. Whereas the ASHRAE-90.1 standard tries to be strictly neutral in the HVAC system type, the public building energy standard recommends certain system types from the point of view of energy rationalization and efficiency. The Chinese standard also tends to give more design guidance, rather than simply listing the

requirements of the standard. For specific heating and cooling equipment, e.g., boilers, chillers, the standard, like the residential one, relies on existing energy efficiency grades and requires that the equipment be above a certain grade.

86 Jiang Lin, "Made for China: energy efficiency standards and labels for household appliance", Environmental Energy Technology Division, Lawrence Berkeley National Laboratory.

87 Data from APEC ESIS, see: http://www.apec-esis.org/countryoverview.php?country=China

88 While this program sets a new pace for developing countries, China's approach is to set easy-to-meet standards intended to eliminate the least efficient 10 to 15 percent of products, making the standard relatively low compared with industrialized countries. Another problem is that the government is the sole actor in developing and designating new standards. Other stakeholders are notified only when the standard development is well under way. More transparency in the process, a clearer timeline for standards and label development, and the ability to make revisions to proposed changes would all reduce the uncertainties that manufacturers face and thus make it easier to comply with the standard and label requirements. The lack of effective implementation and enforcement is another problem. The number of products on the market that comply is unknown and no penalties exist for non-compliance. Comprehensive monitoring and enforcement mechanisms are needed to ensure that all manufacturers produce and sell only appliances that fully comply with the standards. Penalties for non-compliance are also necessary. It is also argued that China needs to better coordinate the development of its standards and labels with international programs in the interest of reducing trade barriers and promoting exports.

89 According to Chinese building energy experts, this green building standard is very brief and general, and not well-developed. Its terms are vague, not specific, and difficult for implementation (Interview with Jin Ruidong, Consultant, Natural Resource Defense Council, U.S. Green Building Council, May 22, 2006, Beijing). However, it is a good start, and it is hoped to serve as a market

pull that might encourage more developers to go green. In Shanghai, it is said that the standard has aroused considerable interest among developers, and the government received many inquires about it just a few days after it became effective (Interview with Wang Wei, Deputy Director, Shanghai Research Institute of Building Science, June 7, 2006, Hong Kong).

[90] Interview with Ruiying Zhang, Program Officer for Buildings & Industry, China Sustainable Energy Program, The Energy Foundation (Beijing), May 2006, Beijing.

[91] For example, the Shenzhen municipal government recently announced interest-free mortgages for hotels that install thermal ice storage systems—a technology that shifts energy consumption to off-peak hours.

[92] Data from Energy Efficiency Office, "Hong Kong Energy End-use Data", Electrical and Mechanical Services Department, The Government of Hong Kong Special Administrative Region, see: http://www.emsd.gov.hk/emsd/e_download/pee/hkeeudb_2006full_20070116.pdf

[93] Energy Efficiency Office, "A Decade of Energy Efficiency & Conservation", Electrical and Mechanical Services Department, The Government of Hong Kong Special Administrative Region, see: http://www.emsd.gov.hk/emsd/e_download/pee/eeo_10y_a[2].pdf

[94] Electrical and Mechanical Services Department, The Government of Hong Kong Special Administrative Region, see: http://www.emsd.gov.hk/emsd/eng/pee/index.shtml

[95] Commercial buildings refer to offices, shops, department stores, and other buildings with commercial purposes, but do not include schools, residential buildings, factories, or garages.

[96] Lee W.L. and Yik F.W.H, 2002, "Regulatory and voluntary approaches for enhancing energy efficiencies of buildings in Hong Kong", *Applied Energy*, Volume 71, Issue 4, pp. 251-274.

[97] The electric household appliances include refrigerators, room coolers, washing machines, electric clothes dryers, compact fluorescent lamps, electric storage water heaters, electric rice cookers, dehumidifiers, televisions, and electronic ballasts. The single gas household appliance

participating in this scheme is instantaneous water heaters. Office equipment includes photocopiers, multifunction devices, laser printers, LCD monitors, computers and fax machines.

[98] Electrical and Mechanical Services Department, The Government of Hong Kong Special Administrative Region, see: http://www.emsd.gov.hk/emsd/eng/pee/classb.shtml

[99] Lee W.L. and Yik F.W.H, 2002, "Regulatory and voluntary approaches for enhancing energy efficiencies of buildings in Hong Kong", *Applied Energy*, Volume 71, Issue 4, pp. 251-274.

[100] Telephone interview with Kevin Edmunds, Chief Operating Officer, Business Environment Council, April 2007, Hong Kong.

[101] See: http://www.energyland.emsd.gov.hk

[102] Electrical and Mechanical Services Department, The Government of Hong Kong Special Administrative Region, see: http://www.emsd.gov.hk/emsd/eng/pee/lceabc.shtml

[103] Unless specified, data in this section were provided by The Energy and Resources Institute (TERI) in India in 2006.

[104] Carbon Sequestration Leadership Forum (CSLF), 2006, "An energy summary of India", See: http://www.cslforum.org/india.htm

[105] At 0.16 kgoe/$GDP (PPP) it is lower that that of China's and the United States of America's, which are at 0.23 kgoe/$GDP (PPP) and 0.22 kgoe/$GDP (PPP) respectively, but fares higher than the intensities of the United Kingdom's at 0.14 kgoe/$GDP (PPP) and Brazil & Japan's at 0.15 kgoe/$GDP (PPP).

[106] International Energy Agency, 2007, "International Energy Annual 2004", see: http://www.eia.doe.gov/iea/overview.html

[107] The Institute of Energy Economics, Japan (IEEJ), 2006, "Asia/World Energy Outlook 2006", see: http://eneken.ieej.or.jp/en/data/pdf/362.pdf

[108] Planning Commission, Government of India, 2006, " Integrated Energy Policy – Report of the Expert Committee", Page XXI, New Delhi.

[109] Big commercial buildings means those have a connected load of 500 kW or greater or a contract demand of 600 kVA or greater.

[110] This means buildings with a conditioned floor area of 1,000 square meters or greater.

[111] Interview with Ajay Mathur, Team Leader, Climate Change, Environment Department, The World Bank, 2007.

[112] Planning Commission, Government of India, 2006, "Integrated Energy Policy – Report of the Expert Committee", p. 49, August, New Delhi.

[113] Bureau of Energy Efficiency, Indian government, 2004, "Action taken Report", see: http://www.bee-india.nic.in/

[114] Bureau of Energy Efficiency, Indian government, see: http://www.bee-india.nic.in/

[115] Unless specifically specified, data in this section are from EC(European Commission)-ASEAN COGEN (Cogeneration) Program, 2004, "National Energy Policy: Indonesia", see: http://www.cogen3.net/doc/policyreview/NationalEnergyPolicyReviewIndonesia.pdf

[116] Data from Korea Energy Economics Institute (KEEI), 2006, "Asia/World Energy Outlook 2006", see: http://www.keei.re.kr/keei/main_eng.html

[117] Data from Korea Energy Economics Institute (KEEI), 2006, "Asia/World Energy Outlook 2006", see: http://www.keei.re.kr/keei/main_eng.html

[118] Data from Yogo Pratomo, 2005, "Implementation of Energy Efficiency Policy in Indonesia", PowerPoint Presentation presented at: "CTI Industry Joint Seminar on Technology Diffusion of Energy Efficiency in Asian Countries", February 24-25, Beijing, China.

[119] Franciscus Sutijastoto, 2006, "Energy Efficiency Policy of Indonesia", Data and Information Center for Energy and Mineral Resources, Ministry of Energy and Mineral Resources (MEMR), the Indonesia government, see: http://www.icett.or.jp/JNT_Work/eew_20060510.nsf/b63b7c6b534d6fb24925716a003d009e/732573f1c6f6d2884925716a003e162a/$FILE/Abstract%20NESIA%20Mr.%20Franciscus%20Sutijastoto.pdf

[120] In the late 1980s an estimate was made of the potential savings from the proposed building energy standard. The estimate was projected using computer simulations of a typical high-rise office building with features

thought to be typical of new Indonesian offices at that time. The annual energy use of this building was simulated, and compared with the building as re-designed to comply with the standard. Projected energy savings were 20 percent from the base-case building.

121 Asia Pacific Energy Research Centre, 2003, "Energy Efficiency Programs In Developing And Transitional APEC Economies," p. 5.

122 Franciscus Sutijastoto, 2006, "Energy Efficiency Policy of Indonesia", Data and Information Center for Energy and Mineral Resources, Ministry of Energy and Mineral Resources (MEMR), the Indonesia government, see: http://www.icett.or.jp/JNT_Work/eew_20060510.nsf/b63b7c6b534d6fb24925716a003d009e/732573f1c6f6d2884925716a003e162a/$FILE/Abstract%20NESIA%20Mr.%20Franciscus%20Sutijastoto.pdf

123 Data from the Institute of Energy Economics, Japan (IEEJ), see: http://eneken.ieej.or.jp/en/index.html

124 In Japan, approximately 90 percent of carbon dioxide produced is energy-related. Under the Kyoto Protocol, Japan agreed to reduce greenhouse gas emissions by 6 percent compared with 1990 during the first commitment period between 2008 and 2012. Following the Kyoto conference, the Long-Term Supply and Demand Outlook was revised in June 1998 on the basis of the contribution of all six greenhouse gases, giving rise to the aim of stabilizing carbon dioxide emissions by the energy sector at the 1990 level by 2010.

125 Martine Fackler, 2007, "Japan Offers a Lesson in Using Technology to Reduce Energy Consumption", *The New York Times,* January 6.

126 For more information, see: http://www.ibec.or.jp/CASBEE/english

127 Unless specified, data in this section are from Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf

128 Data from Malaysia Energy Commission, see: http://www.st.gov.my/

129 Namely: 1) Electricity Supply Act of 1990; 2) Petroleum Development Act; and 3) Air Quality Act of 1974.

[130] This new version of the code allowed for a number of compliance options including: the overall thermal transfer value (OTTV) and roof thermal transfer value (RTTV), maximum thermal transmittance (U-value) for roof, unit lighting power allowance, and air-conditioning equipment ratings. A building is considered energy efficient under the code if it has the potential to consume less than 135 kWh per square meter per year.

[131] Pertubuhan Berita Nasional Malaysia, 2005, "Malaysia Economic News", March 14.

[132] The estimate was projected using computer simulations of a typical high-rise office building with features thought to be typical of new Malaysian offices at that time. The annual energy use of this building was simulated, and compared with the building as re-designed to comply with the requirements of the new building energy standard.

[133] See: http://www.ptm.org.my/ee_building/benchmarking.html

[134] The PTM web site contains a page describing an energy audit program and also provides a list of auditing equipment for rent. See: http://www.ptm.org.my/mieeip/audit.html

[135] See: http://www.tnb.com.my/tariff/newrate.htm

[136] Unless specified, data in this section are from Korea Energy Economics Institute (KEEI), see: http://www.keei.re.kr/keei/main_eng.html

[137] APEC, 2005, *APEC Energy Overview 2005*, see: http://www.ieej.or.jp/aperc/2005pdf/apec_energy_overview_2005.pdf

[138] APEC, 2005, *APEC Energy Overview 2005*, see: http://www.ieej.or.jp/aperc/2005pdf/apec_energy_overview_2005.pdf

[139] Department of Energy, Republic of the Philippines, 1993, "Guidelines for Energy Conserving Design of Buildings and Utility Systems".

[140] For example, Leverage International, 1997, "Philippine New Commercial Building Market Characterization", Final Report, Manila; Busch, John and Deringer, Joseph, 1998, "Experience Implementing Energy Standards for commercial Buildings and Its Lessons for the Philippines", November, Lawrence Berkeley Laboratory Report No. 42146.

[141] For more information, see: http://pelmatp.doe.gov.ph/about.php

[142] Asia Pacific Energy Research Centre, 2003, "Energy Efficiency Programmes In Developing and Transitional APEC Economies", p. 9.

[143] Data from National Climate Change Committee, the Singapore Government, see: http://www.nccc.gov.sg/aboutnccc/report.shtm

[144] Singapore is a party to the UN Framework Convention on Climate Change, or UNFCCC, which sets the overall framework for inter-governmental efforts to address climate change. It has established its own targets as part of its National Climate Change Strategy (NCCS), a part of a larger ten-year environmental initiative known as the Singapore Green Plan 2012, which indicates Singapore's commitment to Sustainable Development. The country aims to reduce its carbon intensity by 25 percent compared to 1990 levels. In 2005, Singapore's carbon intensity was 22 percent below 1990 levels.

[145] Australian Greenhouse Office, 2000, "International Survey of Building Energy Codes".

[146] BEST is capable of calculating the annual heat gain through the building envelope as characterized by the envelope thermal transfer value (ETTV). It also evaluates the annual heat gain through the roof as the roof thermal transfer value (RTTV). Finally, it allows the user to estimate lighting power allowance, receptacle power density, peak system cooling load, sensible heat removal rate, annual cooling energy consumption, and annual total energy consumption based on a set of prescriptive criteria and user-defined design values. See: http://www.bdg.nus.edu.sg/buildingEnergy/software&tools/index.html

[147] See: http://www.bdg.nus.edu.sg/buildingEnergy/about_eric/index.html

[148] More detail and application forms are available at: http://www.bca.gov.sg/GreenMark/GMIS.html

[149] Xinhua General News Services, 2006, "Singapore encourages green building technologies", December 14.

[150] See: http://www.bdg.nus.edu.sg/buildingEnergy/index.html

[151] Under performance contracting, an energy service company (ESCO) finances the implementation of energy-saving measures in a building. The

building owner is therefore spared the cost of upgrading and replacing the existing plant and equipment. When the improvements result in running-cost savings, the building owner benefits and in return the ESCO receives a share of the cost savings over a prescribed period.

152 For more information, see: http://www.bdg.nus.edu.sg/buildingEnergy/showcase/index.html

153 Unless specified, data in this section are from South Korea Energy Economics Institute (KEEI), see: http://www.keei.re.kr/keei/main_eng.html

154 Data from Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf

155 Data from Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf

156 Including residential buildings with over 50 households, office buildings greater than 3,000 square meters, public baths or swimming pools over 500 square meters, hotels and hospitals over 2,000 square meters, department stores over 3,000 square meters, and exhibit halls or schools over 10,000 square meters.

157 For the architectural portion, the mandatory requirements are to meet the specified thermal requirements for the building envelope, install an air barrier inside the insulation to prevent condensation, and add vestibules to building entrances, while the "encouraged" requirements include design strategies such as better siting, minimizing the amounts of walls and windows, and utilizing daylighting, shading, and natural ventilation. For the mechanical portion, the mandatory requirements are to follow existing design conditions and insulation requirements, and minimize the use of electricity during peak hours by use of thermal storage or gas-driven cooling, while the "encouraged" requirements include using high-efficiency appliances and pumps, photovoltaics, heat recovery, ventilative cooling, etc. For the electrical portion, the mandatory requirements include the use of efficient transformers, motors, and lighting, and occupant sensors

for entry lighting, while the "encouraged" requirements include induction motors, demand controllers for peak load conditions, energy-efficient elevators, and High Intensity Discharge (HID) lamps for outdoor spaces.

[158] Although this is not exactly a performance-based standard, other information received from the South Korean Energy Management Company (KEMCO) indicates that standard requirements equate to a heating energy consumption level of 123 kWh per square meter per year for residential and 116 kWH per square meter per year for commercial buildings.

[159] Data from Bureau of Energy, Ministry of Economic Affairs for Taiwan.

[160] Data from Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf

[161] Transportation sector increased from 14 percent to 15 percent, agricultural sector decreased from 4 percent to 2 percent, and others remain at around 8 percent. Data from Bureau of Energy, Ministry of Economic Affairs for Taiwan.

[162] Data from Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf

[163] The key tasks in the energy policy which changes along with the environment include: stabilizing energy supply to increase independent energy; increasing energy efficiency and reinforcing management of energy efficiency; further promoting liberalization of the energy market; coordinating the development of 3E (energy, environment, economy); reinforcing research; and promoting education campaigns and expanding public participation.

[164] Compared to the ENVLOAD indices for the appropriate building type, the Green Building Certification program requires the efficient lighting system design and an additional 20 percent reduction in the building space cooling load in perimeter zones, U Factor or Solar Heat Gain from fenestration, as well as an additional 20 percent reduction in building air-conditioning energy use.

[165] See: http://www.moeaec.gov.tw/Promote/%AB%D8%BFv%AA%AB5%CE%B9q%B0%D1%A6%D2%AB%FC%BC%D0.doc

[166] See: http://www.taipower.com.tw/left_bar/45453err/management_electricity.htm

[167] See: http://www.nstm.gov.tw/english/exhibitions/ex_3.asp?year2=2006#ex27

[168] Unless specified, data in this section are from Asia Pacific Energy Research Institute, 2006, "APEC Energy demand and supply outlook 2006", see: http://www.ieej.or.jp/aperc/2006pdf/Outlook2006/Whole_Report.pdf

[169] Data from ASEAN Center For Energy, 2006, *Energy Efficiency and Conservation in Thailand*, see: http://www.aseanenergy.org/energy_organisations/eec_ssn/thailand/

[170] Designated Facilities are defined under the ENCON Act as facilities with electrical demand greater than 1.0 MW or annual energy use of more than 20 TJ/year of electrical energy equivalent.

[171] For existing buildings, energy-efficient lighting retrofits are often less costly than retrofits of either air-conditioning or envelope systems. Air-conditioning and envelope retrofits, because they usually involve major expenditures, become most attractive economically near the end of the useful life of the existing equipment. Since envelope systems typically last longer than air-conditioning systems, envelope retrofits are less likely to occur than air-conditioning retrofits. For these reasons, some building energy codes for existing buildings have focused on requirements specifically for those portions of buildings being added to existing buildings or undergoing major retrofit. For example, this approach is summarized succinctly in Section 4.2.1 of ASHRAE 90.1-2004.

[172] Apparently the envelope requirements were based on a building with windows for 30 percent of the wall area. Many buildings have much less window area, and such buildings could meet the code requirements without special energy treatment, especially if the windows were also externally shaded.

[173] Apparently a major part of the lighting requirements were based upon the amount of lighting power installed. Some existing buildings in the region

provided levels of illumination that were lower than the assumptions used in the energy code. Such lighting systems might meet the code requirements even without the use of very efficient lighting equipment.

174 This general lack of energy-related technical capability within the technical departments of the local authorities applies not only to Thailand, but to a number of other countries in the region, including the Philippines, Indonesia, Malaysia, and India. Actions to rectify, overcome, or bypass such limitations are of high priority for effective administration and enforcement of any mandatory energy code requirements. However, while Thailand does not currently have the energy skills within the staff of most local authorities, a Thai cadre of certified consultants has been developed from the compulsory energy audit program. A modest refocus of the skills of such consultants might permit them to do both plan checking and inspections of new buildings under design and during construction.

175 Informal electronic communication from Karsten Holm, DANIDA Chief Technical Advisor. Danish Energy Management, February 2007.

176 Based on Jas Singh and Carol Mulholland, 2000, "DSM in Thailand: A Case Study", World Bank, ASTAE.

177 As part of this program the Demand-Side Management Office had also conducted four pilot projects and had purchased and installed 120 load management systems in selected buildings to demonstrate their potential benefits.

178 See: EGAT web site: http://pr.egat.co.th/prweb/new/demandSideManagement.htm

179 See: http://www.reeep.org/media/downloadable_documents/8/p/APEC%20-%20EE%20Revolving%20Fund%20-%20Thailand.pdf

180 See: http://www.dede.go.th/dede/fileadmin/upload/pic_sometime/Energy_Award_2006_Winner.pdf

181 See: http://www.architectureweek.com/2003/0514/environment_1-1.html

182 Including the ASEAN Energy Awards 2003 for Energy Efficient Buildings and ASEAN Energy Awards 2001 for Energy Efficient Buildings.

GLOSSARY

Appliance Energy Standards

Minimum standards of energy efficiency established by governments for energy-consuming appliances.

Appliance Energy-Efficiency Performance Labels

The labels placed on appliances to enable consumers to compare appliance energy efficiency and energy consumption under specified test conditions.

Building Code

Regulations established by a recognized agency, usually governmental, describing design loads, procedures and construction details for structures, usually applying to a designated political jurisdiction (city, county, state, etc.)

Building Energy Efficiency

The efficiency with which a building uses energy. Building energy efficiency generally means using less energy for heating, cooling and lighting, without affecting the comfort of those who use the building. Energy-efficient buildings not only save energy costs and protect the environment by reducing fossil fuel consumption and emissions, but generally also provide a higher-quality indoor environment. Combining energy efficiency with renewable energy is even better for the environment.

Building Envelope

The assembly of exterior portions of a building that enclose conditioned spaces, through which thermal energy may be transferred to or from the exterior, unconditioned spaces, or the ground. In modern buildings, typical materials include glass, concrete, steel and stone.

Building Energy-Efficiency Standards/Codes

Minimum requirements that regulate the energy efficiency of new buildings and/or existing buildings. Building energy-efficiency standards/codes can be mandatory or voluntary, and they can be promulgated by governments, industry associations or private groups. Since their introduction after the oil crises of the 1970s, these standards have spurred an improvement in energy efficiency. The terms "standard" and "code" are used interchangeably.

Building Retrofit

The process of modifying a building's structure; in this study it refers to changes that increase energy efficiency.

Carbon Dioxide (CO_2)

Carbon dioxide is one of the most common greenhouse gases in the atmosphere and is regulated through the natural carbon cycle, where carbon dioxide is emitted into the air and reabsorbed by vegetation and water. This cycle is upset by the emission of additional carbon dioxide from human activities. Because natural cycles cannot absorb these additional emissions, a large portion of carbon dioxide remains in the atmosphere and contributes to climate change. The primary human source of carbon dioxide is the burning of fossil fuels for electricity, heat, and transportation.

Climate Change (Global Climate Change, Global Warming)

Climate change is a significant alteration from one climatic condition to another, beyond the usual alterations in various climates throughout the globe, as the result of human activities. A major contributor to this is fossil fuel combustion, which traps greenhouse gases in the atmosphere. These gases cause gradual changes in the Earth's temperatures over hundreds of years. The term "global warming" may also be used but refers more specifically to temperature, whereas global climate change encompasses the broader changes associated with elevated greenhouse gas levels, such as dryer deserts, increased numbers of hurricanes, loss of biodiversity and warmer oceans.

Commissioning

Commissioning is the process of verifying that a building performs in accordance with the design intent, contract documents and the owner's operational needs. In addition to verification, the commissioning process should include documentation of operating procedures and training of the operator to enable a smooth building handover.

Compact Fluorescent Lamp

Compact fluorescent lamps (CFLs) incorporate a technology that uses much less energy than incandescent or standard fluorescent light bulbs. They come in a range of styles and sizes, and electric utilities often provide instant or mail-in rebates for CFL purchases.

Daylighting (Natural Lighting)

Daylighting is the use of various design techniques to enhance the use of natural light in a building. Daylighting decreases reliance on electric lights and mechanical systems through the use of windows, skylights, light shelves, and other techniques that maximize sunlight while minimizing glare and excess heat.

Double-Paned or Double-Glazed Window

A type of window having two layers (panes or glazing) of glass separated by an air space. Each layer of glass and surrounding air space traps some of the heat that passes through. This insulating air layer increases the windows' resistance to heat gain or loss.

Embodied Energy

The amount of energy required to produce an object at each stages of its development. This refers to the energy needed to create the components that go into a particular object or structure, e.g., the energy required to make all the components that go into a building.

Emissions

Emissions are gases and particles released into the air as byproducts of a natural or human-made process. One of these processes is the burning of fuels to create electricity and other forms of energy. The emissions from burning fossil fuels contribute significantly to global warming and poor air quality. A small set of emissions are responsible for the majority of human impact on global climate change and health. These gases and particulates come from a variety of sources and can be categorized as greenhouse gas emissions (which affect climate change) and air quality emissions (which affect health as well as the environment). One of the primary benefits of clean energy is that it typically produces few or no emissions, significantly reducing climate change and health effects.

Energy Audit

An energy audit identifies where a building uses energy and identifies energy conservation opportunities.

Energy Consumption

The amount of energy consumed in the form in which it is acquired by the user. The term excludes electrical generation and distribution losses.

Energy Efficiency

The amount of energy needed to perform a given function. Increases in energy efficiency take place when either energy inputs are reduced for the same level of service or there are increased or enhanced services for a given amount of energy inputs.

Energy Conservation

Wise use and careful management of energy resources by using energy for a given purpose more efficiently, or reducing energy use altogether. Energy conservation has the connotation of doing without in order to save energy, rather than using less energy to do the some task. The term now is used less. However, some people still use "energy efficiency" and "energy conservation" interchangeably.

Energy Management

While it varies in degree depending on the organization, energy management is generally the structured effort to improve conservation and efficiency as well as consideration of appropriate tariff and energy types. The idea is gaining acceptance as companies around the globe seek ways to address competitive cost pressures, enhance environmental performance and corporate reputation, and reduce risk. Companies that practice good energy management not only enhance their bottom line, but also lessen their energy consumption.

Energy Management System

A control system (often computerized) designed to regulate the energy consumption of a building by controlling the operation of energy-consuming systems, such as the heating, ventilation and air conditioning (HVAC), lighting and water heating systems.

Energy Performance of a Building

Energy performance of a building is the amount of energy actually consumed or estimated to meet the different needs associated with a standardized use of the building. These may include heating, water heating, cooling, ventilation and lighting. This amount uses one or more numeric indicators which take into account insulation, technical and installation characteristics, design and positioning in relation to climatic aspects, solar exposure and the influence of neighboring structures.

Energy Security

The ability to secure reliable supplies of needed energy. Energy security policies typically consider the risk of dependence on fuel sources located in remote and unstable regions of the world and the benefits of domestic and diverse fuel sources.

Energy Service Company (ESCO)

A company that offers to reduce a client's energy consumption. ESCOs typically provide both technical and financial assistance, with the cost savings split with the client.

Final Energy

Energy supplied that is available to the consumer to be converted into useful energy (for example, electricity at the wall outlet).

Glazing

A term used for the transparent or translucent material in a window. This material (for example, glass, plastic films, coated glass) is used for admitting solar energy and light through windows.

Grid

Commonly used to refer to an electricity transmission and distribution system.

Green Building

A building that has been constructed or renovated to incorporate design techniques, technologies, and materials that minimize its overall environmental impact. These include reduced fossil fuel use for electricity and heat, minimal site disruption, lower water consumption, and fewer pollutants used and released during construction and occupation. The term "energy-efficient building" or "high-performance building" is often used when referring specifically to the energy efficiency and productivity benefits of a building, whereas "green building" refers to the broader environmental considerations of a building, including energy-efficient aspects. The emergence of internationally recognized standards, such as LEED has given more empirical basis to the claims of green buildings.

Greenhouse Effect

A popular term used to describe the heating effect due to the trapping of long-wave (length) radiation by greenhouse gases produced from natural and human sources.

Greenhouse Gases (GHG)

While gases like carbon dioxide, methane, nitrous oxide, ozone, and water vapor naturally occur in the Earth's atmosphere, human activities can artificially increase concentrations, notably through fossil fuel combustion to produce heat and electricity. These gases are dubbed Greenhouse Gases because they remain in the atmosphere and intensify the sun's heat as it radiates to the earth, similar to a greenhouse's glass walls heating and moisturizing the air inside it. Greenhouse gases are believed to be the primary source of global climate change.

HVAC System

The HVAC, or heating, ventilation and air-conditioning system, is one of the most energy-intensive parts of modern buildings. Proper design and operation of HVAC systems is key to improving building energy efficiency.

Indoor Environmental Quality

Indoor environmental quality takes into consideration the effects of the indoor environment on human health and performance, including indoor air quality, daylighting and views, and visual and thermal comfort. Energy-efficient and green buildings seek to optimize indoor environmental quality through design that includes properly designed heating, ventilation, and air conditioning systems, abundant windows and proper use of daylighting, and well-sealed doors and windows.

Insulation

A material that keeps energy from crossing from one place to another. In a building, insulation makes the walls, floor, and roof more resistant to the outside temperature, hot or cold.

Integrated Building Design (Whole-Building Design)

Integrated building design, or whole-building design, is the integration of a building's elements and systems to maximize its energy, environmental, and financial performance. A whole building design integrates energy systems to maximize efficiency and reduce the need for electricity, heating, and cooling technologies. The integrated design approach also considers construction materials, indoor environmental quality, acoustics, and other building factors such as design and siting to minimize a building's impact on its surroundings and improve its performance for occupants.

LEED

The Leadership in Environmental and Energy Design (LEED) Green Building Rating System of the U.S. Green Building Council. LEED promotes expertise in green building through a comprehensive system offering project certification, professional accreditation, training and practical resources. To obtain a LEED certification, a building project must satisfy a certain number of prerequisites and performance benchmarks ("credits") related to site sustainability, energy efficiency, material and resource conservation, and indoor environmental quality. Projects are awarded Certified, Bronze, Silver, Gold, or Platinum certification depending on the number of credits they achieve.

Life Cycle of Buildings

In the case of buildings, the entire trajectory of a building's useful life, from the acquisition of raw materials, through construction, operation, upgrading and eventual demolition.

Life-Cycle Cost Analysis

Analyzing a product's entire life from raw materials through manufacture, use, and disposal. For buildings, life-cycle cost analysis takes into account not only the costs of design and construction, but also long-term operating, maintenance, repair, replacement, and disposal costs. Life-cycle cost analysis provides a framework for considering environmental and economic costs over the whole life of a building. One obstacle to designing more energy-efficient buildings has been the reluctance or inability of developers to evaluate costs over the life cycle of the building.

Landscaping

Features and vegetation on the outside of or surrounding a building for aesthetics and energy conservation.

Low-Emissivity (Low-E) Windows

Energy-efficient windows that have a coating or film applied to the surface of the glass to reduce heat transfer through the window.

Passive Building Design

Passive design takes advantage of natural energy flows to maintain a building's thermal comfort, thus reducing the need for mechanical heating or cooling. Buildings that are passively designed maximize cooling air movement and exclude the sun in summer; they trap and store heat from the sun and minimize heat loss to the external environment in winter. Passive design requires careful consideration of the local climate and solar energy resource, building orientation, and landscape features. The principal elements include proper building orientation, proper window sizing and placement and design of window overhangs to reduce summer heat gain and ensure winter heat gain.

Payback Period

The amount of time required before the savings resulting from the investment equal the investment. These are often surprisingly fast with building energy efficiency improvements; in some cases the payback period is less than one year.

Photovoltaic (PV) Panels

PV panels, also called solar panels, convert sunlight directly into electricity. Homes and businesses may incorporate solar panels and arrays as a source of clean energy.

Renewable Energy

Energy derived from resources that are regenerative or, for all practical purposes, cannot be depleted. Types of renewable energy resources include moving water (hydro, tidal and wave power), thermal gradients in ocean water, biomass, geothermal energy, solar energy, and wind energy. Municipal solid waste (MSW) is also considered a renewable energy resource. Renewable energy is also called clean energy as it usually has a low environmental impact, with low or zero emissions, and a minimal impact on the physical surroundings.

Zero-Energy Building

A building with a net energy consumption of zero over a typical year because the energy provided by on-site renewable energy sources is equal to the energy used. Buildings approaching this goal also may be called zero-emission or zero-carbon buildings.

Source: based on glossaries provided by:

- *Multilingual Environmental Glossary, European Environment Agency, see http://glossary.eea.europa.eu/EEAGlossary*
- *Glossary of Energy Terms, California Energy Commission, see http://www.energy.ca.gov/glossary/index.html*
- *Glossary (Energy Efficiency), Energy Information Administration (EIA), the US, see http://www.eia.doe.gov/emeu/efficiency/ee_gloss.htm*
- *Glossary of Energy-Related Terms, the US Department of Energy, see http://www.eere.energy.gov/consumer/information_resources/index.cfm/mytopic=60001*
- *Building Energy Codes Glossary, the US Department of Energy, see http://www.energycodes.gov/support/glossary.stm*
- *Energy Glossary, Massachusetts Technology Collaborative, see http://www.mtpc.org/cleanenergy/energy/glossary.htm*

- *Sustainable Energy Coalition, see http://www.sustainableenergycoalition.org/energy_glossary/s/1.html*
- *Florida Solar Energy Center, see http://www.fsec.ucf.edu/en/education/k-12/curricula/bpm/glossary/index.htm*
- *Glossary of Renewable Energy and Electrical Terms, Montana Green Power, see http://www.montanagreenpower.com/renewables/glossary.html*
- *Glossary of Terms, Community Action Partnership of Ramsey & Washington Counties, see http://caprw.org/index.asp?Type=B_BASIC&SEC=%7BC0E4CC94-26AA-49F1-91C8-E11E2CF49333%7D&DE=%7B32D2EB57-65B7-4AF7-9666-95FEF9A4500B%7D*
- *Best Practice Guide Glossary, Fix Your Power, see http://www.fypower.org/bpg/glossary.html?w=2&b=food%20and%20bev*
- *Glossary, Green Ideas, see http://www.egreenideas.com/glossary.php?group=z*

USEFUL LINKS

These links include organizations whose staff have helped with this study as well as others who work in the area of energy efficiency, broadly defined. We have also included government agencies and departments responsible for buildings and energy.

Worldwide

Alliance to Save Energy
http://www.ase.org/

American Council for an Energy-Efficiency Economy
http://www.aceee.org/

APEC Energy Standard Information System (ESIS)
http://www.apec-esis.org/

Asia-Pacific Partnership On Clean Development and Climate
http://www.asiapacificpartnership.org

ASEAN Center For Energy
http://www.aseanenergy.org/

AutomatedBuildings.com
http://www.automatedbuildings.com/

The Association of Environment Conscious Builders
http://www.aecb.net/

Australian Greenhouse Office
http://www.greenhouse.gov.au/

Best Practices Benchmarking for Energy Efficiency Programs
http://www.eebestpractices.com/

British Columbia Energy Council
http://www.utoronto.ca/

BuildingGreen.com
http://www.buildinggreen.com/menus/headings.cfm?SubtopicID=1

Building Industry Research Alliance
http://www.bira.ws/

Building Research Establishment
http://www.bre.co.uk/

Business Council for Sustainable Energy
http://www.bcse.org/

Climate Change Knowledge Network
http://www.cckn.net/

The Climate Group
http://www.theclimategroup.org/

Cogen3
http://www.cogen3.net/

Collaborative Labeling and Appliance Standards Program (CLASP)
http://www.clasponline.org/

The Department of Design and Construction, the US
http://www.ci.nyc.ny.us/

Development Alternatives Group
http://www.devalt.org/

The Earth Institute
http://www.earthinstitute.columbia.edu/

Ecosustainable Hub
http://www.ecosustainable.com.au/links.htm

Enerdata
http://www.enerdata.fr/

Energy Citations Database
http://www.osti.gov/

Energy Efficient Building Network
http://www.energyefficientbuild.com/

Energy Efficiency and Renewable Energy, The US Department of Energy
http://www.eere.energy.gov/

Energy Efficiency Guide for Industry in Asia
http://www.energyefficiencyasia.org/

The Energy & Environmental Building Association
http://www.eeba.org/

Energy Information Administration (EIA)
http://www.eia.doe.gov/

Energy Institute Press
http://www.energybooks.com/

The Energy Star
http://www.energystar.gov/

EU GreenBuilding Program
http://www.eu-greenbuilding.org/

Flex Your Power
http://www.fypower.org/

Global Ecolabelling Network
http://www.gen.gr.jp/

Global Green USA
http://www.globalgreen.org/

Green Building Council Australia
http://www.gbcaus.org/

Greenbuild
http://www.greenbuildexpo.org/

International Atomic Energy Agency
http://www.iaea.org/

International Code Council
http://www.iccsafe.org/

The International Energy Agency
http://www.iea.org/

International Institute for Energy Conservation
http://www.iiec.org/

International Initiative for a Sustainable Built Environment (iiSBE)
http://greenbuilding.ca/

Lawrence Berkeley National Laboratory
http://www.lbl.gov/

Lead
http://www.lead.org/

Natural Resources Defense Council
http://docs.nrdc.org/

Northwest Energy Efficiency Alliance
http://www.betterbricks.com/

Northeast Sustainable Energy Association
http://www.energycommission.org/

The Office of Energy Efficiency (OEE), Natural Resources Canada
http://oee.nrcan.gc.ca/

Oxford Institute for Energy Studies
http://www.oxfordenergy.org/

Petroleum Conservation Research Association
http://www.pcra.org/

Process Design Center
http://www.process-design-center.com/

Renewable Energy and Energy Efficiency Partnership (REEEP)
http://www.reeep.org/

Renewable Energy Policy Project
http://www.crest.org/

Rocky Mountain Institute
http://www.rmi.org/

Sustainable Architecture, Building and Culture (Sustainable ABC)
http://www.sustainableabc.com/

Sustainable Metropolis
http://www.metropolismag.com/

United Nations Development Programme (UNDP)
http://www.undp.org/

United Nations Framework Convention on Climate Change
http://unfccc.int/

Urban Land Institute
http://www.uli.org/

The U.S. Green Building Council
http://www.usgbc.org/

World Building Design Guide
http://www.wbdg.org/

World Business Council for Sustainable Development (WBCSD)
http://www.wbcsd.org/

World Energy Council
http://www.worldenergy.org/

World Energy Efficiency Association
http://www.weea.org/

World Green Building Council (WorldGBC)
http://www.worldgbc.org/

World Wildlife Fund (WWF)
http://www.panda.org/

China

Beijing Energy Efficiency Center (BECon)
http://www.beconchina.org/

China Sustainable Energy Program, Environmental Foundation
http://www.efchina.org/

China Clean Energy Program, the Natural Resources Defense Council
http://www.chinacleanenergy.org/

China Energy Group, Lawrence Berkeley National Laboratory
http://china.lbl.gov/

China Urban Construction Information Net
http://www.csjs.gov.cn/

Chinese Renewable Energy Industries Association
http://www.creia.net/

Energy Research Institute, National Development and Reform Commission
http://www.eri.org.cn/

Global Village of Beijing
http://www.gvbchina.org/

Ministry of Construction
http://www.cin.gov.cn/

National Development and Reform Commission (NDRC)
http://en.ndrc.gov.cn/

National Renewable Energy Laboratory
http://www.nrel.gov/

United National Development Programme, China
http://www.undp.org.cn/

Hong Kong

Building Energy Efficiency Research, the University of Hong Kong
http://www.arch.hku.hk/research/BEER/

Business Environment Council
http://www.bec.org.hk/

Case Studies for Sustainable Buildings, Department of Mechanical Engineering, The University of Hong Kong
http://www.hku.hk/

Civic Exchange
http://www.civic-exchange.org/

Department of Building Services Engineering, The Hong Kong Polytechnic University
http://www.bse.polyu.edu.hk/

Energy Efficiency Office, Electrical and Mechanical Services Department, The Government of Hong Kong Special Administrative Region
http://www.emsd.gov.hk/emsd/

Energy Land, Electrical and Mechanical Services Department, The Government of Hong Kong Special Administrative Region
http://www.energyland.emsd.gov.hk/

HK-BEAM Society
http://www.hk-beam.org.hk/

India

Bureau of Energy Efficiency, Government of India
http://www.bee-india.nic.in/

Carbon Sequestration Leadership Forum (CSLF)
http://www.cslforum.org/

CII-Sohrabji Godrej Green Business Center
http://www.ciigbc.org/

The Energy and Resources Institute (TERI)
http://www.teriin.org/

Planning Commission, Government of India
http://planningcommission.nic.in/

Indonesia

Ministry of Energy and Mineral Resources (MEMR), the Government of Indonesia
http://www.esdm.go.id/en/

WWF (World Wildlife Fund) - Indonesia
http://www.wwf.or.id/

Japan

Agency for Natural Resources and Energy
http://www.enecho.meti.go.jp/

Asia Pacific Energy Research Centre (APERC)
http://www.ieej.or.jp/aperc/

Comprehensive Assessment System for Building Environmental Efficiency
http://www.ibec.or.jp/CASBEE/english/

Energy Conservation Center, Japan (ECCJ)
http://www.eccj.or.jp/

The Institute of Energy Economics, Japan(IEEJ)
http://eneken.ieej.or.jp/

International Center for Environmental Technology Transfer
http://www.icett.or.jp/

Institute for Building Environment and Energy Conservation
http://www.ibec.or.jp/

Malaysia

Malaysia Energy Commission
http://www.st.gov.my/

Pusat Tenaga Malaysia (PTM)
http://www.ptm.org.my/

Tenaga Nasional Berhad (TNB)
http://www.tnb.com.my/

The Ministry of Energy
http://www.ktkm.gov.my/

Suruhanjay Tenega
http://www.eest.net.my/

Philippines

Philippines Department of Energy
http://www.doe.gov.ph/

The Philippines Efficient Lighting, Market Transformation Project (PELMATP)
http://pelmatp.doe.gov.ph/

Singapore

Building and Construction Authority
http://www.bca.gov.sg/

Department of Building, School of Design and Environment, National University of Singapore
http://www.bdg.nus.edu.sg/

Energy and Environmental Research Group
http://www.ntu.edu.sg/

Energy Market Authority
http://www.ema.gov.sg/

Energy Market Company
http://www.emcsg.com/

Energy Sustainability Unit
http://www.esu.com.sg/

Ministry of the Environment and Water Resources
http://app.mewr.gov.sg/

Ministry of National Development
http://www.mnd.gov.sg/

Ministry of Trade and Industry
http://app.mti.gov.sg/

National Climate Change Committee, the Singapore Government
http://www.nccc.gov.sg/

National Environmental Agency
http://app.nea.gov.sg/

Singapore Environmental Council
http://www.sec.org.sg/

South Korea

ECO-FRONTIER
http://www.ecofrontier.co.kr/

Korea Energy Economics Institute (KEEI)
http://www.keei.re.kr/

Korea Energy Management Corporation
http://www.kemco.or.kr/

Korea Institute of Energy Research
http://www.kier.re.kr/

Ministry of Commerce, Industry and Energy
http://english.mocie.go.kr/

Ministry of Construction and Transportation
http://www.moct.go.kr/

Taiwan

Architecture and Building Research Institute, Ministry of the Interior
http://www.abri.gov.tw/

Building Energy Efficiency Web Site
http://energy.archi.com.tw/

Bureau of Energy, Ministry of Economic Affairs
http://www.moeaboe.gov.tw/

Construction and Planning Agency, Ministry of the Interior
http://www.cpami.gov.tw/

Chinese Architecture and Building Center
http://www.cabc.org.tw/

Industrial Technology Research Institute
http://www.erl.itri.org.tw/

Energy Information Network
http://emis.erl.itri.org.tw/

Green Mark Information Center
http://www.greenmark.org.tw/

Taiwan Power Company
http://www.taipower.com.tw/

National Science and Technology Museum
http://www.nstm.gov.tw/

Thailand

Energy Policy Research Project
http://thaienergy.org/

Ministry of Energy
http://www.energy.go.th/

Department of Alternative Energy Development and Efficiency (DEDE)
http://www.dede.go.th/

Energy Policy and Planning Office, Ministry of Energy
http://www.eppo.go.th/

Energy for Environment Foundation
http://www.efe.or.th/

The Thailand Energy and Environment Network (TEENET)
http://www.teenet.info/

Glossary

Multilingual Environmental Glossary, European Environment Agency
http://glossary.eea.europa.eu/EEAGlossary

Glossary of Energy Terms, California Energy Commission
http://www.energy.ca.gov/glossary/index.html

Glossary (Energy Efficiency)
Energy Information Administration (EIA), the US
http://www.eia.doe.gov/emeu/efficiency/ee_gloss.htm

Glossary of Energy-Related Terms, the US Department of Energy
http://www.eere.energy.gov/consumer/information_resources/index.cfm/my-topic=60001

Building Energy Codes Glossary, the US Department of Energy
http://www.energycodes.gov/support/glossary.stm

Energy Glossary, Massachusetts Technology Collaborative
http://www.mtpc.org/cleanenergy/energy/glossary.htm

Sustainable Energy Coalition
http://www.sustainableenergycoalition.org/energy_glossary/s/1.html

Florida Solar Energy Center
http://www.fsec.ucf.edu/en/education/k-12/curricula/bpm/glossary/index.htm

Glossary of Renewable Energy and Electrical Terms, Montana Green Power
see http://www.montanagreenpower.com/renewables/glossary.html

Glossary of Terms, Community Action Partnership of Ramsey & Washington Counties
http://caprw.org/index.asp?Type=B_BASIC&SEC=%7BC0E4CC94-26AA-49F1-91C8-E11E2CF49333%7D&DE=%7B32D2EB57-65B7-4AF7-9666-95FEF9A4500B%7D

Best Practice Guide Glossary, Flex Your Power
http://www.fypower.org/bpg/glossary.html

Glossary, Green Ideas
http://www.egreenideas.com/glossary.php?group=z

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Interviewees (in alphabetical order; surnames are last)

1. Constant van Aerschot, Director Construction Trends, Lafarge; also Co-Chair of the Energy Efficiency in Buildings (EEB) Project of the Would Business Council for Sustainable Development (WBCDS)
2. Robert Allender, Managing Director, Environmental Resources Management
3. John Ashton, Chief Executive, Third Generation Environmentalism (E3G) (currently Special Representative for Climate Change, the UK Foreign and Commonwealth Office)
4. Toby Bath, Managing Director/Senior Vice President, HOK International (Asia/Pacific) Ltd.
5. Abraham Boyd, Assistant Marketing Manager, Southeast Asia Region, HOK International (Asia/Pacific) Ltd.
6. John Burnett, Chair Professor of Building Services Engineering, Hong Kong Polytechnic University
7. Pitarn Chaichinda, Assistant Director, Demand Side Implementation Division, Demand Side Management Office, Electricity Generating Authority of Thailand
8. Cary W.H. Chan, Head of Technical Services, Swire Properties Management Ltd.
9. L. C. Chan, Assistant General Manager, Fleet Management Department, Orient Overseas Container Line Ltd.
10. Ronnie C. Chan, Chairman, Hang Lung Group Ltd.
11. Steve H. H. Chan, Local Director, FSG-North Asia Management Solutions, Jones Lang LaSalle
12. Peggy Chu, Architect, HOK International (Asia/Pacific) Ltd.
13. H. N. Daruwalla, Vice President, Electrical and Electronic Division, Godrej & Boyce Manufacturing Co., Ltd.
14. Jan Decoloedt, Technical Consultant, Robinsons Land Corporation
15. Kevin Edmunds, Chief Operating Officer, Business Environment Council

16. Barbara Finamore, Director, China Clean Energy Program, Natural Resources Defense Council
17. Ping He, Program Manager, Energy & Environment, United Nations Development Program
18. John A. Herbert, Managing Director, Kelcroft Consulting Engineers
19. Christopher Ho, Assistant General Manager, Property Management, Keppel Land International Ltd.
20. Steven Howard, CEO, The Climate Group
21. Jianxin Hu, Deputy General Manager, China Merchants Property Development Co., Ltd.
22. Sam C.M. Hui, Teaching Consultant, Department of Mechanical Engineering, The University of Hong Kong
23. Ruidong Jin, Consultant, Natural Resource Defense Council
24. Gail Kendall, Director for Environment, China Light and Power Group
25. Myung-Soo Kim, Executive Managing Director, Lotte Moolsan Co., Ltd.
26. Shunichi Kuriyama, General Manager, Sanyo Electric Co., Ltd.
27. Shiu Wo Lam, Senior Manager, Project Development, Hang Lung Properties Ltd.
28. Seng-Eon Lee, Director, Building and Urban Research Department, Korea Institute of Construction Technology
29. Siew Eang Lee, Professor, Department of Building School of Design and Environment, National University of Singapore
30. Tony K.Y. Leung, Senior Superintendent, Fleet Technical Section, Orient Overseas Container Line Ltd.
31. Victor Leung, Assistant General Manager, Technical Services, Hysan Development Co., Ltd.
32. Tow Fok Lim, General Manager, Property Management, Keppel Land International Ltd.
33. Sin On Lim, Engineering Manager, Property Management, Keppel Land International Ltd.

34. Chanwut Limpichai, Senior Engineer, Engineering Division, Siam Cement Industry Co., Ltd.
35. Numpol Limprasert, Energy Manager, Engineering Division, Siam Cement Industry Co., Ltd.
36. Wu Sheng Lin, Planning & Designing Center, China Merchants Property Development Co., Ltd.
37. Junyao Liu, Vice Chief and Chief Engineer, Shenzhen Building Research Institute
38. Christine Loh, CEO, Civic Exchange Ltd.
39. Roberto A. Lozada, Professional Mechanical Engineer, RCL Engineering Department, Robinsons Land Corp.
40. Geronimo B. Magsombol, Assistant Vice President, Plant Engineering Division, Integrated Microelectronics, Inc.
41. Chen Namchaisiri, Member of the Executive Committee, Vice Chairman Executive Committee, the Institute of Industrial Energy, the Federation of Thai Industries
42. Tommy Lee O, Vice President, Complex Administration, Robinsons Land Corp.
43. Minxin Pei, Senior Associate, Carnegie Endowment for International Peace
44. Napaporn Phumaraphand, Assistant Vice President, Demand Side Management and Planning Division-Technical, EGAT Public Company Ltd.
45. Mallika Prasertsom, Assistant Senior Manager, Appliance Efficiency Improvement Project, Demand Side Implementation Division, EGAT Public Company Ltd.
46. Inh-Bae Roh, Director, Lotte Engineering & Construction Co., Ltd.
47. P. Rumi, Engineer, Godrej & Boyce Co. Mfg., Ltd.
48. Liam Salter, Coordinator, Asia Pacific Climate & Energy Program, WWF International
49. Jimmy G. Sanchez, Deputy CFO & Controller, Integrated Microelectronics, Inc.

50. Jon Seller, General Manager, Optegy Ltd.
51. Teresa Serra, Sector Director, Environment & Social Development Program (Asia), the World Bank
52. Peter Shaw, Senior Manager, Corporate Real Estate Operations, Corporate Real Estate Asia Pacific, Hong Kong and Shanghai Banking Corporation Ltd.
53. Terence Siew, Director, Strategic Policy Division, Singapore Ministry of the Environment and Water Resources
54. Sean Silvey, Head of Environmental Sustainability, Australia and New Zealand Banking Group Ltd. (ANZ)
55. Siwei Lang, Advisory Vice General Engineer, China Academy of Building Research; Vice President, Chinese Association of Refrigeration
56. Daryl Sng, Assistant Director (Air), Strategic Policy Division, Singapore Ministry of the Environment and Water Resources
57. Min-Ho Song, Lotte Moolsan Co., Ltd.
58. Zhi Gang Su, Innovation and Research Department, China Vanke Co., Ltd.
59. Kriengkrai Suksankraisorn, Engineer, Engineering Division, Siam Cement Industry Co., Ltd.
60. Joji Suwa, Senior Manager, Strategy Business Unit, Strategy Headquarters-International Business Group, Sanyo Electric Co., Ltd.
61. Wee Hock Tan, Deputy Director (Land) Strategic Policy Division, Singapore Ministry of the Environment and Water Resources
62. Andrew Thomson, CEO, Business Environment Council
63. Sir Crispin Tickel, Director, Green College Centre for Environmental Policy and Understanding, Oxford University
64. Helen Tong, Manager-General Administration, Corporate Administration, Orient Overseas Container Line Ltd.

65. Sajin Varghese, Senior Press Officer, Philips Electronics Hong Kong Ltd.
66. Arthit Vechakij, Managing Director, Excellent Energy International Company Ltd.
67. Wei Wang, Deputy Director, Shanghai Research Institute of Building Science
68. Robert Watson, Chairman & CEO, American SinoTech
69. Pauline Wong, Executive Director, Hysan Development Co., Ltd.
70. David K.C. Yau, Assistant General Manager, Project Management Department, Henderson Land Development Co., Ltd.
71. Inseop Yoo, Senior Managing Director, Lotte Engineering & Construction Co., Ltd.
72. Lee Kia Young, Project Manager of The Tresor, Keppel Land
73. Peter Young, Property Center Manager, Exchange Square Property Center, Hongkong Land (Property Management) Ltd.
74. Liang Yu, Managing Director, China Vanke Co., Ltd.
75. Ning Yu, President, Environment and Development Foundation
76. Grace Yuen, Associate, HOK International (Asia/Pacific) Ltd.
77. Ruiying Zhang, Program Officer for Buildings & Industry, China Sustainable Energy Program, the Energy Foundation
78. Shawn Zhang, Energy Management Specialist, Guangdong Esquel Textiles Co., Ltd.
79. Xin Zhang, CEO, SOHO China Ltd.

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What Asia Business Council Members Say About *Building Energy Efficiency*

"The study concentrates on market-based solutions to an important aspect of the energy and environmental challenges the region faces. Buildings account for nearly one-third of energy use and a similar proportion of total global greenhouse gas emissions. More than half of the world's new construction is taking place in Asia. Studies estimate that China and India could cut current building energy consumption by 25 percent simply by using energy more efficiently. Similar savings are available for many other Asian countries."

Narayana Murthy
Chairman & Chief Mentor
Infosys Technologies, India
Chairman, Asia Business Council

"The many examples of economically efficient and environmentally friendly buildings in this study show that many businesses in Asia have been raising standards through their own actions, and that an increasingly sophisticated market is showing a preference for higher-performance buildings. This has important implications for the building and property industry in the region."

Qin Xiao
Chairman
China Merchants Group, China
Vice Chairman, Asia Business Council

"This book is the first Asian look at what is quickly becoming a significant international trend. Examples of green buildings in Asia in *Building Energy Efficiency: Why Green Buildings Are Key to Asia's Future* give it a useful corporate perspective while the detailed comparison of relevant government policies across the region will prove a useful reference for policy makers throughout Asia."

Stan Shih
Chairman & General Partner
iD SoftCapital, Taiwan
Trustee and Chairman Emeritus, Asia Business Council

"Sustainable development is not just the preserve of governments, NGOs, policy makers or greenies. Everyone has a part to play: businesses, consumers, teachers, parents, children and every conceivable institution and organization. This Asia Business Council publication, *Building Energy Efficiency: Why Green Buildings Are Key to Asia's Future*, is both timely and a good start made by Asian businesses."

Lim Chee Onn
Executive Chairman
Keppel Corporation Ltd, Singapore
Trustee, Asia Business Council

"This is the first comprehensive study in Asia examining the opportunities for governments, businesses, NGOs and individuals to improve energy efficiency in the building sector. This wide-ranging work shows both market-based solutions and promising policy approaches to achieve the increasingly important goal of dramatically improved building energy efficiency. Global warming and climate change are amongst the most important issues that have to be faced and addressed by both the developed and the developing countries. Energy efficiency, water recycling and building materials have received very little attention so far. If we are to avoid a catastrophic climate change, we have to limit global warming within the 2° centigrade limit. If every building that is built or renovated can be a green building, certified to meet international standards, saving energy and water, then we can have a significant solution to global warming. Green buildings will be a major contributor to sustainable development."

Jamshyd Godrej
Chairman & Managing Director
Godrej & Boyce Manufacturing Co. Ltd., India

"The high-speed, fast-paced building boom in Asia is one where architectural design and marvelous appearances should now be refocused to concentrate on energy efficiency and 'green movement' considerations. Buildings should consider the four Rs: redesign, rethink, recycle, and reduce so that construction is in line with the essential elements of efficiency."

Douglas Tong Hsu
Chairman & CEO
Far Eastern Group, Taiwan

"As Asia experiences continuing economic and population growth, we must put greater emphasis on more efficient energy use. The Asia Business Council's far-reaching report on better resource utilization should be of wide interest to readers throughout the region."

Lee Woong-Yeul
Chairman
Kolon Group, South Korea

"This important study provides compelling reasoning that improving the energy efficiency of buildings can significantly help China and other Asian countries to address both energy security and environmental challenges and to secure social and economic development."

Levin Zhu Yunlai
Chief Executive Officer
China International Capital Corp., China

"It is heartening to find that the Asia Business Council has focused on the energy efficiency of buildings in Asia. This report is extremely valuable, particularly since the Asian region is experiencing a building boom, and correct designs and building practices at this stage can ensure energy efficiency and limitations on emissions of greenhouse gases for decades to come."

R K Pachauri, PhD
Chairman, Intergovernmental Panel on Climate Change

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