

Business Focus Series

The Energy Efficiency Market in Developing Countries: Trends and Policy Implications



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ACRONYMS AND ABBREVIATIONS

ASD	Adjustable speed drive
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
CFB	Circulating fluidized bed
CFC	Chlorofluorocarbons
CFL	Compact fluorescent lamp
DDC	Digital direct control
DSM	Demand-side management
ESCO	Energy service company
GDP	Gross domestic product
HVAC	Heating, ventilation and air-conditioning
kWh	Kilowatt hour
ISO	International Standards Organization
MDB	Multilateral development bank
MW	Megawatt
NGO	Non-governmental organization
O&M	Operations and maintenance
OECD	Organization for Economic Cooperation and Development
OEM	Original equipment manufacturer
R&D	Research and development
SITC	Standard international trade classification
T&D	Transmission and distribution
USAID	United States Agency for International Development

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EXECUTIVE SUMMARY

New market drivers are rapidly expanding the market for energy-efficient goods and services in developing and emerging market countries. Though a number of barriers still remain, the energy efficiency market in developing countries and emerging market nations is much more robust and varied than it was just 20 years ago.

This study was undertaken in order to identify the new trends in the market for energy-efficient products in developing countries. Understanding where the markets are growing and changing will help policy makers determine where international donor agency attention and resources should be focused *now* in order to produce the greatest overall benefits over the next two decades. In order to find that focus, the study's authors and researchers concentrated on collecting data that would help them characterize the current market, outline expected trends, and recommend strategic action to take advantage of new trends in developing country markets.

This information is of particular interest to international donor agencies, companies marketing energy-efficient products, and high-level policy makers within developing countries who are determined to capture the full economic benefits of energy efficiency for their countries.

The data, as presented in this report, provide the first bottom-up characterization of the developing country energy efficiency market to date. Rather than attempting to predict the *potential* size of the energy efficiency market between 1996 and 2015, this study focuses on collecting information about the most probable *actual* size of the market for energy efficiency technologies and services, using 1996 as the base year.

Two scenarios have been used to estimate the market size for energy efficiency in 2015: a conservative growth scenario, which assumes that growth in the energy efficiency market is commensurate with GDP growth, and an aggressive growth scenario, which takes into account regional variations in technology growth, likely actions by multinational corporations and multilateral development banks, and assumptions about penetration rates of specific energy-efficient technologies.

ES.1 MARKET CHARACTERISTICS AND TRENDS

The global energy efficiency market is diverse. It covers products and services designed to meet a variety of technical needs and to manage costs or resources in all sectors. The current market for energy-efficient products and services can be summarized by the following characteristics and general trends:

Market Fragmentation Energy efficiency markets are fragmented. This situation dictates that providers of different energy-efficient products take diverse approaches to marketing their goods. There is no one single market structure that encompasses all energy-efficient products or services. Structures and penetration rates vary by country, region, and technology.

Variation in Energy Sector Conditions Energy sector conditions vary both regionally and from country to country, affecting energy efficiency markets. In emerging market economies, multilateral development agencies and bilateral donors, along with local governments, are the key catalysts for introducing market forces and supporting energy efficiency in the energy and industrial sectors. Energy price reform has already occurred in many emerging market countries and energy prices are approaching marginal costs and world market levels. These costs, in turn, drive market demand for energy efficiency. In developing countries, energy price reform, power sector restructuring, and environmental concerns are transforming the markets for energy and energy efficiency more slowly. Energy shortages are still the greatest factor driving the developments of energy efficiency markets in developing countries. Many developing countries view energy efficiency as one measure they can take to help alleviate current and projected energy shortages. The long-term effects of power sector restructuring in all countries has yet to become fully evident.

Shifting Markets Market opportunities are shifting from OECD countries to newly industrialized developing countries, due to several factors. The developing world is experiencing high rates of growth in energy demand, due to increasing energy usage per capita and rising urban populations. These high growth rates are expected to continue over the next decade and beyond, and are coupled with a slow-down in the rate of new construction and industrial expansion in the U.S., Canada, and Western Europe.

Restructuring and Demand-Side Management Both demand side management (DSM) and restructuring are attracting substantial interest in developing countries. DSM is viewed as a means of implementing load management and energy conservation, reducing brown outs and black outs in the short-run and reducing capital outlays for new generation capacity in the long run. Restructuring of the electric sector is typically undertaken as a means to open the power sector to private capital investment and to introduce competition in the generation, transmission, or distribution of power. As in the U.S., power sector demonopolization and deregulation is expected to open the market to broader competition for energy services, including energy management and efficiency services.

Construction Boom The construction boom taking place in the developing world presents significant market opportunities for energy-efficient products and services in all sectors. Asia's market is projected to grow fastest, averaging 11% growth through 2015. This boom presents both opportunities and barriers for energy efficiency markets. The sheer volume of new construction will certainly expand the markets for energy-efficient products such as glazed windows, insulation, lighting and building controls. In addition, increased private sector involvement in the construction industry will likely stimulate demand for higher quality, more advanced products. In the residential sector, growing middle classes have more disposable income to spend, further fueling market growth. Residential construction will likely be dominated by low-income housing, however, which is unlikely to be a significant market for energy-efficient products with higher first costs. Construction practices also vary from country to country, and in some cases there are biases against energy-efficient products.

Worldwide Oil Market The World Energy Council projects that developing countries will account for about 90% of the increase in world oil consumption between 1985 and 2020. This puts significant upward pressure on oil markets and could lead to both higher prices and greater volatility in the market. The expectation is that oil prices will continue to remain stable for the foreseeable future. However, if oil prices were to rise sharply, the economic benefits of energy efficiency investment would improve dramatically.

Greenhouse Gas Reduction A growing interest in energy efficiency in developing countries comes from the threat of global climate change and commitments made to help reduce emissions. Generally speaking, increased emissions of greenhouse gases, such as from burning of fossil fuels in power generation, accelerate global climate change. Thus, technologies with smaller energy requirements indirectly influence climate change in a positive way. Because carbon emissions are a global rather than a local problem, multilateral organizations and donor agencies are beginning to redefine their role in this area, to focus on more regional and global cooperation to achieve larger benefits.

ES 2 MARKET OUTLOOK

What is an “energy-efficient” product or service? Because of the difficulty of identifying and describing energy-efficient products, a working definition was established for the purposes of this report. In general, energy-efficient products were taken to mean those products which have energy efficiency performance ratings as their distinguishing feature, apart from all other options or models in their product line. In some cases, this meant taking into account items that were self-described or marketed by their manufacturers as energy-efficient. Included in this category are products that conserve all types of energy, not just electricity. Some of the more common examples include lighting, air conditioners, refrigerators, and motors.

To assist in measuring and categorizing energy-efficient products, the market was broken up into eight key end-use technology markets. These are:

- ▶ Building controls and heating, ventilation and air conditioning (HVAC) equipment
- ▶ Building envelope (windows, insulation, etc.)
- ▶ Cogeneration equipment and services
- ▶ Household appliances
- ▶ High efficiency boilers
- ▶ Industrial process controls
- ▶ Industrial motors and adjustable speed drives (ASDs)
- ▶ Lighting

Market Behavior and Growth Assumptions U.S. Department of Commerce import statistics for 1993, adjusted for 1996, have been used as a baseline for the data presented in this report. Using this method, the size of the total energy efficiency market in developing countries in 1996 was estimated to be \$9.5 billion. To make the 2015 projections, two different scenarios were created, producing estimates representing the upper and lower limits on the likely market size.

- ▶ **Conservative growth scenario** This scenario used prevailing economic growth rates (based on historical GDP data) to make straight line projections for country and technology market sizes in 2015. Some secondary differentiation was made in the projections based on the level of domestic manufacturing capability present in individual country markets. Under this scenario, the total market size in 2015 is estimated to be \$30.7 billion.
- ▶ **Aggressive growth scenario** This scenario assumes that energy efficiency markets will grow faster than the economies of most countries due mainly to increased technology penetration. Using a variety of industry data sources, such as manufacturer sales statistics, telephone interviews with manufacturing representatives, other business focus series reports, and Hagler Bailly proprietary data, this scenario estimates a larger market size in 2015, at \$66.7 billion.

Figure ES-1 gives an overview of the market projections.

Figure ES-1 Market Summary			
Item	1996	2015 (conservative)	2015 (aggressive)
Market Size	\$9.5 billion	\$30.7 billion	\$66.7 billion
Largest regional market	Asia	Asia	Asia
Largest country market	China	China	China
Largest market segment	Process controls	Process Controls	Lighting
Fastest growing region	Asia	Asia	Asia
Fastest growing technology market	Motors	Motors	Lighting
Largest technology markets	Building	Process Controls	ASDs
Overall	Envelope	Building Envelope	ASDs
Asia	Building	Building Envelope	Building Controls
Africa/Middle East	Envelope	Lighting	ASDs
Eastern Europe	Building	Process Controls	Lighting
Latin America	Envelope		
	Lighting		
	Process Controls		

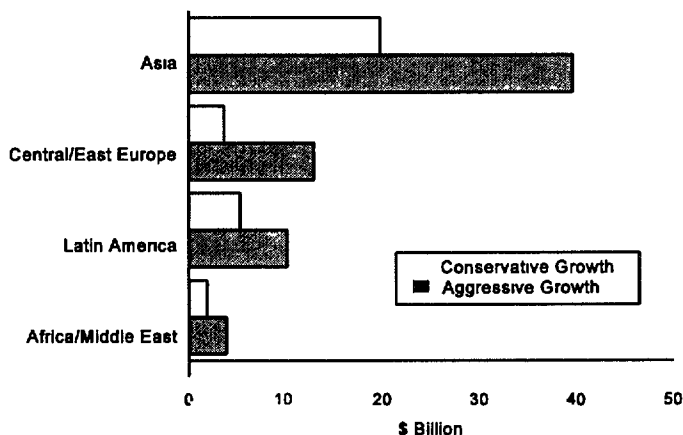
Source: Hagler Bailly Inc.

Regional Market Overview Asia was the largest regional market by value in 1996, accounting for 58% of the total market for energy-efficient products and services. The markets for energy efficiency in the other three regions were notably smaller. Africa was the smallest market, with a share of only 8%. The Latin American market accounted for 20% and Eastern Europe accounted for 15% of the overall market. Figure ES-2 summarizes the projections of market size by region in 2015, using both a conservative growth scenario and an aggressive growth scenario. In the conservative scenario, Asia will remain the largest market, with a 64% share. Latin America will be second with 17%, followed by Central/Eastern Europe and Africa with 12% and 6%, respectively. Under the aggressive growth scenario, Asia will again

Figure ES-2

2015 Energy Efficiency Market

Range of Potential Market Size



Source: Hagler Bailly Inc.

be the largest market, comprising 59%, while Central and Eastern Europe will eclipse Latin America for second place, with 19%. Latin American and Africa/Middle East will follow with 15% and 6%, respectively.

Technology Market Overview

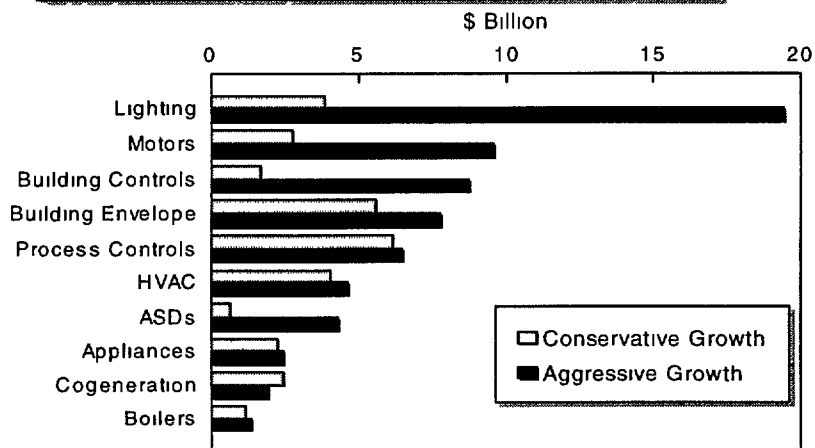
Figure ES-3 summarizes the expected developing country technology markets for 2015. Under the conservative growth scenario, process controls are projected to be the largest overall market, while the aggressive growth scenario projects lighting to be nearly twice the size of the next largest market (for motors).

The dominance of lighting is chiefly due to its wide application across all sectors. In addition, the four fastest growing technology markets between 1996 and 2015 are likely to be lighting, motors, ASDs, and building controls.

Source: Hagler Bailly Inc.

Figure ES-3

2015 Energy Efficiency Market By Technology



ES 3 MAJOR POLICY ISSUES AND IMPLICATIONS

The characteristics of the energy efficiency market today have major implications for policy makers both within developing countries and outside them. There are a number of strategies that donor agencies, policy makers, and efficient technology manufacturers can use to target investments in order to realize the greatest potential gains in energy efficiency, while avoiding the lost opportunities occurring daily in high-growth developing countries. The most important task for policy makers is to understand the energy efficiency market that already exists. This will allow policy to be recalibrated to take best advantage of market characteristics and trends for the largest possible energy savings. Other strategic recommendations include the following:

- ▶ A mismatch currently exists between countries targeted for donor agency attention and those with the most potential for energy efficiency gains. Donor agencies should look closely at the high industrial and commercial growth countries of Southeast Asia and not at societies that are still primarily agrarian.
- ▶ Rapid growth requires action now to avoid losing opportunities in the future.
- ▶ The opportunity to build awareness is a key tool available to policy makers. Governments and international agencies are in the best position to offer information and education services that will ensure that energy-efficiency technologies are recognized in the market.
- ▶ A new international agency should be created with a mandate for addressing greenhouse gas reduction and global climate change mitigation. This would ensure international and intra-sectoral cooperation on these global, cross-boundary issues.
- ▶ The dominance of multinational corporations in the energy efficiency market puts pressure on nations to act jointly.
- ▶ Market aggregation strategies such as financing support will be a key element in fostering a stronger energy efficiency market. Small players with little capital at their disposal will need to be brought into the market.
- ▶ The energy efficiency market in developing countries is growing fastest in those technologies amenable to efficiency gains through the implementation of appliance and building standards. Again, international cooperation on this issue can make such initiatives even more successful by creating economies of scale and addressing market failures.

A major challenge for policy makers is to take these strategic recommendations and formulate them into a concrete action plan which prioritizes the most important countries, regions, sectors and technologies in terms of potential energy savings. Table ES-1 below gives a preliminary set of countries and technology markets recommended for attention in the short-term (the next two years) and the medium-term (two to five years).

Table ES-1 Priority Countries and Technologies		
Country/Technology	2015 Market Size Aggressive estimate (\$ml)	Market Growth Rate (%)
Short Term		
Hong Kong	\$6,602	14.4
Lighting	\$4,717	18.0
Singapore	\$3,621	13.0
Lighting	\$1,393	16.0
Motors	\$1,033	15.0
Indonesia	\$3,156	10.6
Building Controls	\$644	15.6
Motors	\$787	15.0
South Korea	\$6,965	10.3
Building Controls	\$1,356	15.6
Motors	\$2,380	13.9
Medium Term		
China	\$7,545	9.8
Lighting	\$1,782	18.0
HVAC	\$1,274	9.0
Russia	\$5,925	12.8
Building Controls	\$1,220	16.9
Lighting	\$1,210	13.9
Brazil	\$3,242	9.0
Building Envelope	\$932	9.5
Lighting	\$571	16.0

Source: Hagler Bailly Inc.

The countries and technologies recommended for attention in the short term were chosen on the basis of their high growth rates which will result in a great many lost opportunities if action is not taken now. All of these countries are in Southeast Asia and do not receive significant investment or attention from international donor agencies at the present time. The most important technologies for short-term attention in these countries are those with applications in the industrial and commercial sectors that are experiencing explosive growth. In the medium term, the countries and technologies given priority generally have slower average growth rates, but still represent large potential markets. China represents the single biggest market for energy-efficient technologies anywhere in the world. The lighting market is projected to be the largest technology market by the year 2015.

1. INTRODUCTION

In nearly all OECD countries, a large market for energy-efficient products and services already exists. This has been the case since the oil price shocks and energy security issues emerged in the 1970s, when the economic benefits of energy efficiency became readily apparent and supportive government policies were implemented in most OECD countries. While the impact of oil price shocks has long been absorbed, energy efficiency markets continue to expand. Supportive government policies have remained in place, new policies have been developed, and the cost-benefit ratio of energy efficiency is still attractive, though the current trend toward restructuring of the power sector may have as yet unforeseen implications.

By contrast, the energy efficiency wave of the 1970s largely bypassed developing countries. National governments lacked the institutional capabilities to implement energy-efficient policies and countries experienced varying degrees of difficulty accessing the resources to acquire energy-efficient solutions. Far from making energy efficiency a compelling economic alternative, subsidized energy prices often caused it to be a low priority, a situation that is still the case in some areas. Other barriers exist in the form of limited foreign exchange for importing energy-efficient equipment, lack of awareness of technologies, and low income levels.

Today and for the foreseeable future, new market drivers are expanding the market for energy-efficient goods and services in developing countries. While a number of barriers still remain, the market in developing countries and emerging market nations is much different today than it was just 20 years ago.

This study was undertaken in order to identify the new trends emerging in the energy efficiency markets of developing countries. The purpose is to take a broad look at where international donor agency attention and resources should be focused now in order to receive the greatest overall benefits over the next two decades. In order to find that focus, data were collected to characterize the current market, outline expected trends, and recommend policies for overcoming barriers to energy efficiency in order to take best advantage of new trends in the developing country market.

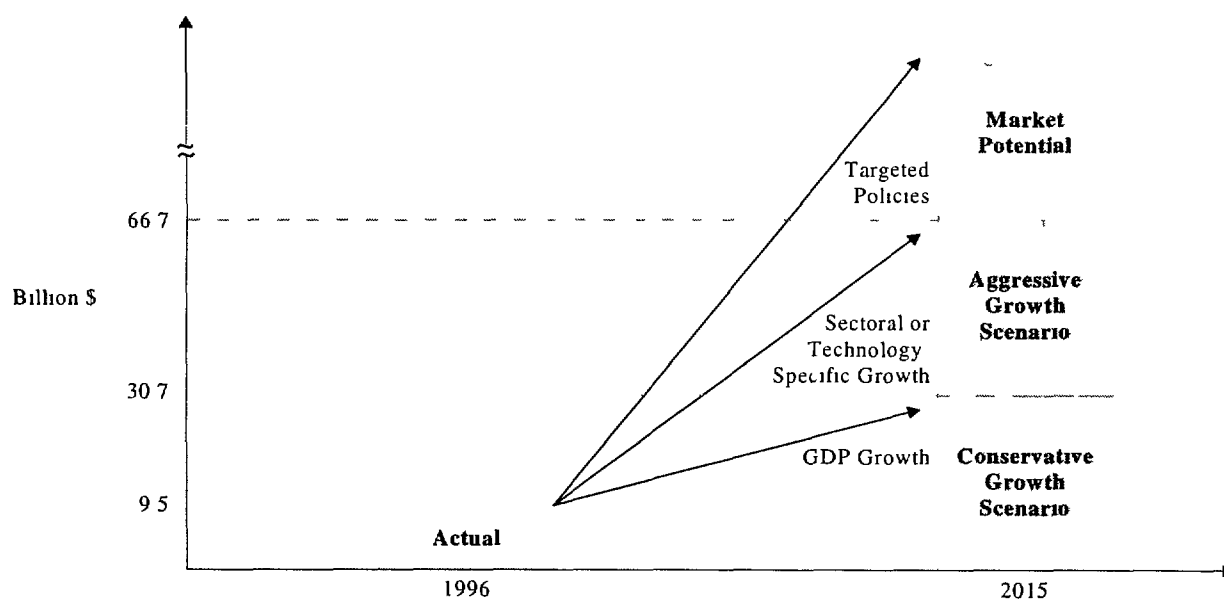
The audience for this report is broad, including international donor agencies and multinational corporations marketing energy-efficient products, as well as high-level policy makers within developing countries who are determined to capture the full economic benefits of energy efficiency for their countries.

Data for this report were collected using a variety of sources, including import data for different technologies, manufacturer sales statistics, telephone interviews with manufacturer representatives, other published reports, and U.S. Department of Commerce data. These numbers were then analyzed and combined with historical growth rate analysis to project likely market trends between now and 2015. For a more detailed description of this methodology, see Chapter 2.

The data, as presented in this report, provide a comprehensive characterization of the developing country energy efficiency market, spanning numerous technologies and geographic markets. Rather than attempting to predict the *potential* size of the energy efficiency market between 1996 and 2015, this study focuses on collecting information about the most probable *actual* size of the market for energy efficiency technologies and services. We estimate future market values by closely correlating them with prevailing growth rates in regional and technology markets in general.

Two scenarios have been used to estimate the market size for energy efficiency in 2015: a conservative growth scenario, which assumes that growth in the energy efficiency market is commensurate with GDP growth, and an aggressive growth scenario which takes into account regional variations in technology growth, likely actions by multinational corporations and multilateral development banks, and optimistic assumptions about penetration rates of specific energy-efficient technologies. This scenario is 'aggressive' because it results in a market size estimate that is considerably larger than under the 'conservative' scenario. Figure 1 gives a graphical representation of the conceptual framework.

Figure 1
Conceptual Framework for Estimating Developing Country Energy Efficiency Market Size



Chapter 2 of this report outlines the prevailing trends influencing the market for energy-efficient products in 1996 and beyond. Some of these trends will determine whether the size of the market in 2015 reaches that predicted by the aggressive growth scenario or only that predicted by the conservative growth scenario. Chapter 3 summarizes the probable market size in 2015 under both scenarios. Chapter 4 focuses on policies and recommendations which are likely to move the market from its predicted *actual* level towards a more robust *potential* size.

This report offers the data to provide a global perspective on the energy efficiency market analyzed in two major cross sections

- ▶ regional and country markets, and
- ▶ technology markets

Previous studies have been inclined to focus on sectoral dimensions (industrial, commercial, or residential) of the energy efficiency market. Although the data presented in this report can be classified in this manner (as in Figure 2), it is more useful from a policy perspective to look at the data from a regional, country and technology perspective. The market was divided into cross sections of regions and/or countries and technology markets with the ultimate objective of defining strategies for driving the energy efficiency market toward its full potential by 2015. Breaking this objective down into its component parts, this report addresses the following questions:

1. What regions and/or countries provide the greatest opportunities for energy efficiency market growth?
 - ▶ What is the magnitude of the opportunity?
 - ▶ Where do barriers exist now?
2. What technologies, with attention and market push, offer the best potential opportunities?
 - ▶ What is the magnitude of the opportunities?
 - ▶ What are the projected growth rates?
3. What combinations of countries and technologies offer the best potential opportunities?
4. What policy or intervention strategies logically follow from the answers to questions 1-3 and can help achieve the potential opportunities identified therein?

Using this framework, the report suggests where the markets for energy efficient technologies are likely to occur, and therefore where international donor agencies and developing country policy makers should focus their attention in order to realize the greatest gains in energy efficiency over the next two decades.

2. MARKET TRENDS AND CHARACTERISTICS

The global energy efficiency market is generally characterized more by its differences than by its similarities. This may be inevitable since energy efficiency is often a solution and not a specific product or service. Market characteristics discussed in this section focus on the differences in market structure, regional energy sector conditions, and market penetration rates of a diverse group of energy-efficient products.

Overall trends in the energy efficiency market include a shift in market opportunities from industrialized countries to developing and emerging market countries. Another discernable trend is the consolidation of the industry as a relatively small number of multinational firms begins to dominate manufacturing and sales of energy-efficient products.

2.1 MARKET FRAGMENTATION

Energy efficiency markets are fragmented. This situation dictates that providers of energy-efficient products take diverse approaches to marketing their goods. There is no one single market structure that encompasses all energy-efficient products or services, and this fact also means that market opportunities will vary from country to country. The complexity of the energy efficiency industry is illustrated by the following:

- ▶ The market includes a diverse group of finished goods, components, engineered systems and energy-service companies that provide engineering, project management, finance, and software development expertise to deliver savings to energy users.
- ▶ The industry encompasses diverse end-use applications in the residential, commercial, industrial, agricultural and transport sectors (see Figure 2).
- ▶ Distribution channels vary widely, both by product/service and by country. Some products are available “off the shelf” such as lighting, while others are sold through sales representatives who may or may not provide after-sales parts and service. The complexity of the distribution system is, in part, dependent on the size of the economy and the amount of local manufacturing and/or assembly.
- ▶ Project sizes also vary widely. The cost of energy efficiency projects may range from a few hundred dollars for steam traps to millions of dollars for cogeneration systems and more extensive

Figure 2
Types of Energy Efficiency Projects

Energy efficiency projects can be categorized by end-use sector, as shown below. Many of the projects involve the installation of new systems or technologies or the retrofit of existing equipment. Alternatively, a project may consist of an end user contracting for energy audits or services.

Commercial

Heating, ventilation and air conditioning
Systems (HVAC)
Groundwater heat pumps
Load management systems and controls
Cogeneration
Refrigeration systems/freezers
Lighting
Building controls
Insulation
Low-emissivity windows
Window coatings and films
Energy audits/services
Power factor correction systems

Agricultural

Water Pumpsets
Pumping systems

Industrial

Process controls
High-efficiency boilers
Cogeneration
Combustion controls
Waste heat recovery boilers
Insulation
Energy/load management systems
High-efficiency motors/adjustable speed drives
High-efficiency lighting
Energy audits/services
Power factor correction
Stream traps

Residential

Efficient appliances
HVAC
Groundwater heat pumps
Lighting

industrial system retrofits. The upper limit on the size of an individual energy efficiency project is generally thought to be around \$30 million.

The result of this highly fragmented market is that there can be no universal rules to identify market opportunities. There are no typical energy efficiency projects, and projects are not easily standardized. Marketing approaches and market development are therefore dependent in part on four factors: distribution channels, product knowledge, buyer concentration, and market barriers.

Distribution channels Most international equipment manufacturers rely on local agents or exclusive distributors to get their products to the market. To reach large industrial or commercial consumers, sales may proceed directly from a distributor to the consumer. For residential consumers, on the other hand, retail stores are usually a necessary link in the distribution chain. Other potential participants in distribution include utilities (e.g. to implement a demand-side management program), building contractors, specification engineers, architects, and local governments. (Appendix B discusses the distribution practices of each product or technology in greater detail.)

Training and product knowledge To insure effective marketing and after-sales service, manufacturers typically provide their distributors, local agents or other key marketers with specialized product training. Accurate product knowledge can be critical to overcoming information barriers that limit product sales.

Training is also critical for products that generally require after-sales service or maintenance. Lack of after-sales service can seriously hamper market penetration of more sophisticated energy-efficient products.

Buyer concentration Providers of energy-efficient products and technologies confront varying levels of buyer concentration. This is an important factor since initial market entry and development can often be facilitated by the existence of concentrated sources of demand. In general, residential sector demand is quite diffuse. Window manufacturers, for example, have sold few energy-efficient windows to residential consumers in part because they are difficult to reach. On the industrial and commercial side, on the other hand, utilities or other large buyers often step in and organize the market, accelerating the penetration levels of energy-efficient products. Lighting is an excellent example of a technology market segment benefiting from buyer concentration in the industrial and commercial sectors. Typical consumers of lighting in developing countries are governments, utilities, and construction companies, all of which are capable of purchasing large quantities of lighting products.

Market barriers The market barriers for energy-efficient products in developing countries are well documented in the literature.¹ They include, but are not limited to, trade barriers (import duties or quotas), high consumer discount rates, lack of investment capital or availability of financing, difficulty of obtaining energy-efficient products, energy pricing, energy sector inefficiencies, lack of information and training, lack of government capability and leadership, and lack of leadership and commitment by the donor community. Each market segment faces its own unique market barriers. For example, the development of cogeneration markets can be dependent on government regulations that permit the sale of excess electricity to the local grid. In the residential sector, the sale of efficient household appliances is more likely to be affected by price differentials between energy-efficient and standard appliances. In all sectors, building envelope technologies must be adapted to different construction practices. Examples of these barriers abound.

2.2 VARIATIONS IN ENERGY SECTOR CONDITIONS

Energy sector conditions vary both regionally and from country to country, affecting energy efficiency markets. What follows is a discussion of the characteristics of industrialized countries, emerging market economies, and developing countries, with respect to energy sector conditions.

Industrialized Countries Utilities in industrialized countries face two major trends that will affect the markets for energy-efficient products: industry restructuring (including privatization) and growing environmental concerns. Restructuring and privatization are transforming utilities in industrialized countries from fully-integrated franchise owners to competitive service providers offering both energy products and services. In the area of energy efficiency distribution, utilities are seeking to forge close customer relationships that will allow them to sell a range of energy services. In some cases utilities are establishing subsidiaries, free from regulation, that can deliver these energy services. Environmental

¹See, for example, Michael Philips, *The Least Cost Path for Developing Countries*, International Institute for Energy Conservation, September 1991.

concerns are also leading utilities to consider energy efficiency improvements as a way to reduce greenhouse gas emissions. These two trends are major drivers for energy efficiency markets in industrialized countries, but they are not yet the most important drivers for developing countries. This trend promises to change in the medium term.

Emerging Market Economies Multilateral development agencies and bilateral donors, along with local governments, are the key catalysts for introducing market forces and supporting energy efficiency in the energy and industrial sectors of these countries. In many countries, energy price reform has already occurred and energy prices are approaching marginal costs and world market levels. In many former communist countries in Eastern Europe, however, energy price reform will take some time to be fully implemented. Nonetheless, privatization of the industrial sector means that enterprises have an incentive to implement energy efficiency where no incentives previously existed under the communist economic system. As a result of many of these economic changes, the attractiveness of energy efficiency is improving and consequently markets are expected to expand. In the short term, however, the region as a whole is seriously capital-constrained, providing a significant barrier to energy efficiency.

Developing Countries Like the industrialized countries and emerging market economies, developing countries are finding that energy price reform, sector restructuring, and environmental concerns are transforming the markets for energy and energy efficiency. In the short term, energy shortages are the greatest factor driving the development of energy efficiency markets in developing countries. Many developing countries view energy efficiency as one measure they can take to partially alleviate current and projected energy shortages and offset the need for increased generation capacity.

2.3 MARKET PENETRATION RATES

Energy-efficient products make up only a portion of the total product sales in any one market segment. Thus, a critical factor in determining the size of the energy efficiency market is determining the level of penetration of energy-efficient technologies. This is a difficult task for a number of reasons, including

- ▶ Definitions of what constitutes ‘energy-efficient’ are constantly evolving to reflect new or stricter standards and to adjust to technological improvements.
- ▶ In a developing country setting, most new product models introduced to the market are likely to incorporate the latest technology and are therefore more efficient. (This statement was repeated many times by manufacturers interviewed for this report.)
- ▶ Even if product standards do exist, they are not internationally uniform nor are standard testing methods used to determine efficiency levels.
- ▶ Import and other sales statistics do not differentiate between ‘efficient’ and ‘normal’ products.

- ▶ The energy-efficient feature of a product may be used as a marketing tool for manufacturers particularly in developed countries but there is no regulation of the marketing terminology Therefore, claims that products are "high efficiency" or "super efficiency" lose their objectivity

In short, comprehensive data on market penetration rates for energy efficiency technologies do not exist

2.4 SHIFTING MARKETS

Another trend occurring in the energy efficiency market today is the shift in market opportunities from industrialized countries to developing countries There are several reasons for this shift The most important is that the developing world is experiencing high rates of growth in energy demand These high growth rates are expected to continue over the next decade or more Increasing energy usage per capita and rising urban populations demanding more and better electrical services in developing countries are also driving this shift The trends discussed below contribute both directly and indirectly to a greater need for energy conservation in these countries, providing growing opportunities for energy-efficient technologies

Many developing countries are experiencing rapid growth in energy and electricity demand, creating incentives for energy efficiency The shift in markets to developing countries is partially correlated with the rapid growth in energy demand occurring there Asia, in particular, is driving the increase in demand for end-use energy Energy growth in the developing countries of Asia is projected to average 4.2% per year through 2015 compared with 1.3% growth per year for industrialized countries ² Although many factors influence growth in energy demand, rapid economic growth is expected to be the major contributor in many developing countries For example power demand in Indonesia is expected to grow by 17% per year for the period 1991-2005, and in the Philippines by 8% per year Brazil is expected to experience 4% annual growth in electricity use for 2000-2010 ³

Electricity is the fastest growing form of end-use energy worldwide Consumption of electricity worldwide is projected to approach 20 trillion kWh in 2015, nearly double the level of 1995 ⁴ Electricity demand in developing countries could rise sharply as these countries attempt to expand electricity services to a greater portion of their population In 1990, 50% of the population in developing countries did not have access to electricity Average electricity generation per capita in developing countries is only 660 kWh, compared with 10,500 kWh per person in the U.S. High levels of economic growth being experienced in many developing countries could also cause a massive increase in electricity consumption Over time, it has been typical for electricity demand growth to approximate 1.5 times the rate of economic growth of a country

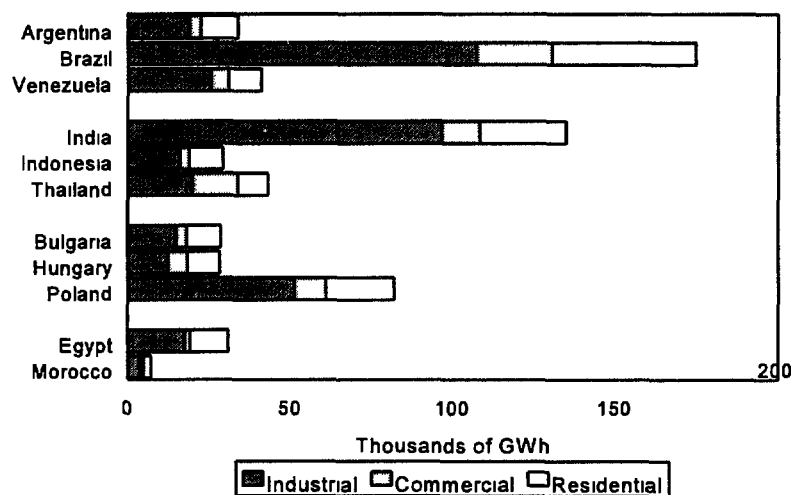
Energy consumption varies by sector As Figure 3 illustrates, the industrial sector is typically the major consumer of energy However, energy use in the residential and commercial sectors is now growing at a

²Energy Information Administration *International Energy Outlook 1997* Washington D.C. 1997

³U.S. Department of Commerce *ASEAN Market Sector Reports* 1995

⁴Energy Information Administration *International Energy Outlook 1997* 1997

Figure 3
Electricity Consumption By Sector
Selected Countries (1991)



Notes: Figures for Brazil are for 1989; India, 1990.
 Source: World Bank, *Power Sector Statistics for Developing Countries, 1987-1991*

faster rate than industrial energy use. In Thailand, for example, residential energy is forecast to grow at an average annual rate of 11% over the period 1991 to 2005. This compares to a 10% annual growth rate in the industrial sector for the same period.⁵ The trend is similar in four other Asian countries (India, Indonesia, Korea and China)

Energy intensity is increasing in many developing countries at the same time it is dropping in industrialized countries. Energy intensity in industrialized countries has declined steadily since the

1980s, to some degree reflecting improvements in energy efficiency. By contrast, during the period between 1983 and 1993, energy intensity rose in Indonesia (10%), Philippines (24%), Morocco (11%), Brazil (5%), and in the Czech and Slovak republics (7%).⁶ The countries with the highest ratio of energy consumption to GDP are now mostly developing countries, creating the potential for energy-efficient technologies to make a greater impact on energy consumption in these countries. Eastern European and other countries with post-communist industrial facilities typically use nearly twice as much energy per unit of output as Western European countries, mainly due to inefficient manufacturing processes.

Urbanization will increase the demand for many energy-intensive services. Urbanization in developing countries is occurring faster than population growth: urban populations are growing at 3.5% per year. The combination of declining economic opportunities in rural areas and increased job opportunities and services in urban communities is drawing populations to cities. By some estimates, four billion people in developing countries will be classified as urban by 2025.⁷ Latin American countries already have extremely high rates of urbanization. In Argentina the percentage of the population living in urban areas of 1 million or more people is 43%. In Uruguay it is 42%, in Chile and Brazil 38%.

⁵World Bank, *Energy Demand in Five Major Asian Developing Countries, 1993*

⁶OECD, *Energy Statistics and Balances of Non-OECD Countries, 1993*

⁷World Resources, *A Guide to the Global Environment, 1993*

2.5 ELECTRIC UTILITY INVOLVEMENT IN ENERGY EFFICIENCY

Both demand side management (DSM) and power sector restructuring are attracting substantial interest in developing countries. DSM is viewed as a means of implementing energy conservation, reducing brown-outs and black-outs in the short run and reducing capital outlays for new generation capacity in the long run. Restructuring of the electric sector is typically undertaken as a means to open the power sector to private capital investment, introduce competition in the generation, transmission, or distribution of power and increase operating efficiencies.

Experience with utility DSM programs in the United States has demonstrated that utilities need financial or regulatory incentives to implement DSM programs, because successful DSM programs ultimately reduce utility revenues when less power is sold to the consumer. Thus, left to their own decisions, utilities will raise electricity rates to compensate for lost revenues. This result is now untenable because of competitive pressures on electricity prices.

The situation in developing countries is slightly more complex because often electricity is not priced at the marginal cost level, but segments of consumers are instead charged subsidized rates. Utility bills often go uncollected or electric bills become the objects of political bargaining. These conditions must be corrected if energy efficiency is to become a viable option.

Restructured power markets alter the relationships and incentives necessary as a precondition for DSM programs to be successful. The United Kingdom's experience with restructuring provides a good example.⁸ The regulatory scheme in the U.K. that initially existed after restructuring offered a strong incentive for utilities to *maximize* electricity sales. No provisions were made in the new scheme for DSM program cost recovery or lost revenues. Only through the introduction of regulation were the incentives put in place for the implementation of energy efficiency.

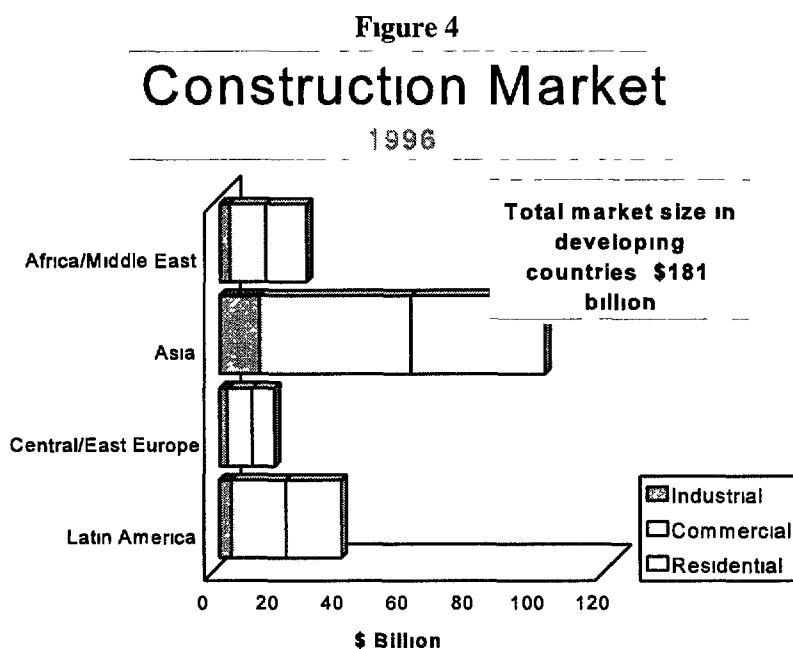
Experience in the United Kingdom (and similar experiences in other countries) raises a legitimate question as to what effect power sector restructuring will have on utility DSM programs, and, in turn, how energy efficiency markets will be affected. There is currently no effective measure of this "swing factor." It will depend, in large measure, on the path countries take towards restructuring and what incentives for encouraging end-use efficiency are built into any newly restructured system.⁹

⁸Two papers discuss the role of energy efficiency in the U.K. energy market: *DSM in Restructured Markets* by Michael King, Grayson Heffner, Stale Johansen, and J. Brian Kick, and *Energy Efficiency in the Competitive U.K. Energy Supply Market* by Craig Mickle.

⁹USAID recently completed a study on the implications of power sector restructuring for energy efficiency. The draft report is entitled *Promoting Energy Efficiency in Reforming Electricity Markets: A Guidebook for Stakeholders*. Draft report, 1997.

2.6 CONSTRUCTION BOOM

Figure 4 shows the estimated construction market in 1996 at \$181 billion¹⁰ This figure represents a construction boom occurring in the developing world and includes trade in both products and services in the commercial, industrial and residential sectors In the building sector, construction is assumed to mean everything that goes into a building, up until the time it is ready to be occupied, including construction of the shell itself, windows, insulation, building controls, and HVAC systems Also included are non-material inputs such as construction labor and revenues of architectural design firms Asia's market is projected to grow fastest, averaging 6% annual growth through 2000



Source: Economist Intelligence Unit

This construction boom presents both opportunities and barriers for energy efficiency markets The sheer volume of new construction will expand the markets for energy-efficient products such as glazed windows, insulation and building controls In addition, increased private sector involvement in the construction industry will likely stimulate demand for higher quality, more advanced products In the industrial sector, especially in Asia, unprecedented growth is taking place In the residential sector, growing

middle classes are beginning to seek ways to differentiate themselves from their neighbors and spend their income, further fueling market growth Residential construction will likely be dominated by low-income housing, however, which is unlikely to be a significant market for energy-efficient products with higher first costs Construction practices vary from country to country, and in some cases there are strong biases against some energy-efficient products These factors are discussed in more detail below

The greatest opportunities for energy-efficient technologies exist in new commercial (and public building) construction The construction sector is struggling to keep up with the pace of population and commercial growth, and demand for business office space, hotels, shopping centers, hospitals, and schools

¹⁰This figure includes spending on infrastructure projects such as roads, railways, and ports Infrastructure projects account for a significant portion of the market in some cases infrastructure projects will claim an estimated 40% of the total market

is high throughout the developing world. In many countries the need for commercial and public sector buildings is driving the growth in the construction industry. High quality products are often preferred for commercial construction, indicating the possibility of a receptive market for energy-efficient technologies. In addition, foreign investors will want high quality technologies to be used by their branch offices, joint ventures, and subsidiaries.

The urgent need for new commercial buildings, coupled with a bias against renovating existing buildings, means that the greatest number of opportunities for energy efficiency in the construction market exist in new construction. In most countries undergoing a construction boom, the efforts will be focused on building new modern structures, rather than updating existing ones. Renovations to existing buildings are expensive. The retrofit of an old building and installation of new insulation or windows requires the hiring of a contractor to demolish the area, remove the debris, and install the new material or equipment, all of which can be costly. The major exception to this generalization is in Eastern Europe and the former Soviet Union, where a significant building stock already exists and the amount of new construction required is therefore lower. In that particular region, however, capital constraints do not currently allow for much investment at all, whether in new construction or in retrofits.

Growing middle classes in many countries are searching for ways to differentiate themselves. There is growing demand for private homes by the emerging middle classes throughout the developing world. As they improve their standard of living they may be willing to purchase higher quality building products. However, a major barrier to the development of private residential markets is the lack of financing available to the general public. To counter this problem many governments are instituting new financial mechanisms to facilitate the availability of home mortgages. A few countries have established some home financing programs including the Philippines, Czech Republic, Poland, Russia, and Argentina. Presumably, these middle classes will purchase other goods such as home appliances at about the same rate they are buying new homes.

The private sector is increasingly playing a role in stimulating markets for higher quality energy-efficient products. Many countries are opening up the construction industry to foreign competition. Engineering and construction companies such as Bechtel International, Fluor Daniel, Dillingham Construction, and Parsons Brinckerhoff are conducting business in just about every region of the world. In addition, many countries have already privatized or are in the process of privatizing state-owned construction companies. These efforts should increase the efficiency of the construction industry, creating lower costs, more rapid growth, and potentially larger markets for advanced building products. To push this process, the World Bank, European Union, and other donors have included the provision of basic support to the construction and related industries as one of their central requirements for lending. The greatest impacts from these transitions will be seen in Eastern and Central Europe and China, where the central government has historically played a dominant role.

Low income housing design typically specifies less expensive, lower quality building materials, and therefore does not create much of a demand for energy-efficient technologies. In many countries residential construction has not kept pace with population growth or urban migration. As a result, serious housing shortages exist. A few examples of this deficit follow.

- ▶ India had a housing shortage of 31 million units in 1991 roughly one-quarter of its entire stock India will need an estimated 80 million additional housing units by the year 2000 to meet the existing backlog and new demand The Eighth Five Year Plan (1992-97) allocated \$25.8 billion to the housing sector
- ▶ Indonesia's urban housing shortage is approximately 1.5 million units Approximately 2.5 million square meters of new space will be built each year through 2000 for the residential sector
- ▶ The Czech Republic needs to construct 50,000 units each year until 2010 to combat its current housing shortage
- ▶ Poland has a housing shortage of 1.3 million units, roughly 10% of its existing stock The solution may require building roughly 200,000 homes each year until the year 2020
- ▶ Mexico has a shortage of seven million residential units
- ▶ In the next 10 years, the government of Kuwait plans to build two new towns, each with more than 50,000 homes, at a cost of \$10 billion

While the inevitable residential construction boom resulting from these shortages may seem to offer a potential market for energy-efficient technologies, the reality is probably not so bright Most of the above deficits will be met by building public, low income, low cost housing Because less expensive, lower quality materials are typically specified for these structures, the demand for energy-efficient lighting, appliances, windows, and other technologies will likely be relatively small However, a government interested in promoting these products could develop standards for materials and equipment to be used in state-funded projects Also, as markets for energy-efficient products expand, the cost premium will probably decline

Construction practices are biased against western-style building products Building methods in the developing world provide another barrier for some energy-efficient technologies For example, homes in Asia, Eastern Europe, and Latin America are typically made of concrete, blocks (or brick), and mortar These types of structures do not permit the use of the energy-efficient insulation batts that are so popular in the United States In addition, manufacturers of insulation and wood windows commonly sell their products as integral parts of prefabricated homes, they cannot do this in developing countries where a market for such homes does not exist In developing countries, prefabricated homes are not perceived as "solid" enough to withstand storms, earthquakes, or fires This is especially important in regions such as Latin America, where families change homes only a few times during their lives and a home is likely to be inherited by the children in the family Houses in the developing world are also smaller than those in the U.S. This creates a barrier to energy-efficient products exported from the U.S. and designed for larger spaces However, some European and Japanese models are available that can bridge this gap and are becoming increasingly popular

2.7 WORLDWIDE OIL MARKET

Another factor influencing the penetration of energy-efficient products is the state of the world oil market The World Energy Council projects that developing countries will account for about 90% of the increase in

world oil consumption between 1995 and 2020. This will put significant upward pressure on oil markets and could lead to both higher prices and greater volatility in the market.

The developing world possesses only limited crude oil reserves, with a ratio of reserves to production of 26 years compared to a worldwide ratio of 43 years. These reserves are concentrated in a few countries. Three-quarters of developing countries depend on imports for all or most of their commercial energy supplies. Oil imports can be a considerable strain on already tight foreign exchange budgets.

On the other hand, oil prices have remained stable for many years even in the face of potential supply disruptions, such as the Persian Gulf War in the early 1990s. The expectation is that oil prices will continue to remain stable for the foreseeable future. However, if this does not turn out to be the case and oil prices rise sharply, the economic benefits of energy efficiency investments would likely improve dramatically.

2.8 GREENHOUSE GAS REDUCTION

A major impetus for a growing interest in energy efficiency in developing countries comes from the threat of global climate change. This point has been emphasized in recent conferences and political speeches taking place throughout the world. It is a generally accepted scientific concept that increased emissions of greenhouse gases (GHGs) result in a greater impact on global climate change. Recently, international attention has become focused on energy efficiency as a way to help reduce carbon emissions and thus mitigate their effect on global climate change. Because of the global nature of the climate change issue and the recognized role of energy efficiency in addressing it, multilateral organizations are beginning to think of their responsibility in developing countries in broader terms. Programs targeted at emissions in one country, even a relatively large one, will have only a minor impact on global emissions. Thus, donor agencies are beginning to take a more integrated approach to policies targeted to reduce greenhouse gas emissions and global climate change. Individual countries have also made commitments to emissions reductions under the UN Framework Convention on Climate Change, and this has served to stimulate their interest in energy efficiency as a means to fulfill those commitments.

All of the energy-efficient technologies examined in this report reduce carbon emissions by using less energy, thereby requiring less burning of fossil fuels to generate electricity. Though this is a simplified explanation of the relationship, and does not take into account certain externalities in the process, there is generally an established positive correlation between increased energy efficiency and reduced carbon emissions.

Although it is beyond the scope of this study to estimate the exact magnitude of the reduction of emissions correlated with the growth of the energy efficiency markets estimated in this report, it is generally assumed that a more robust market for energy-efficient products in developing countries will result in saved energy, which in turn will reduce greenhouse gas emissions and result in less global climate change. This study uses dollars to estimate the size of the energy efficiency market, showing only an indirect link between one dollar spent on an energy-efficient technology and the number of BTUs of energy saved. Without knowing

BTUs saved, it is impossible to pinpoint an exact reduction in greenhouse gas emissions. This is because \$1 worth of energy-efficient lighting equipment, for example, may not save as much energy as \$1 worth of insulation. Thus, for the purposes of this analysis, we have assumed a loosely positive correlation between dollar size of market and energy (and thus carbon emissions) saved.

3. MARKET OUTLOOK

An estimate of the size of the market for energy-efficient products depends in part on the answers to two important questions

- ▶ What is an “energy-efficient” product or service?
- ▶ How is the market being defined?

3.1 DEFINITION OF AN ENERGY-EFFICIENT PRODUCT

No clear definition of an energy-efficient product or service exists in the marketplace today. As discussed earlier, these products cannot be generalized or easily described by traditional identification measures such as purpose or end-use. Nor is the constituency easily identified, for example, a commercial establishment may be just as interested as a homeowner in having an efficient refrigerator.

In many cases the energy-efficient product cannot even be readily distinguished from other products in the same product group. The only distinguishing feature of an energy-efficient refrigerator may be a performance rating that promises the use of less electricity. In terms of how it should be marketed, this refrigerator may have more in common with other energy saving equipment such as fluorescent lighting and building controls than it does with other refrigerators. However, as yet, no discrete marketing identity exists for energy-efficient products as a group.

Because of the difficulty of identifying and describing energy-efficient products, a working definition has been established for the purposes of this report. In general, energy-efficient products are taken to mean those products which have energy conservation as the feature that distinguishes them from all other options in their product line. Occasionally, this means taking into account items simply because their manufacturers have described them as energy-efficient. This approach has obvious limitations, since no worldwide standards exist to determine or measure the energy efficiency of particular products.

To assist in measuring and categorizing energy-efficient products, the market was divided into eight key end-use technology markets:

- ▶ Building controls and heating, ventilation and air conditioning (HVAC) equipment
- ▶ Building envelopes
- ▶ Cogeneration equipment and services
- ▶ Household appliances
- ▶ High efficiency industrial boilers

-
- ▶ Industrial process controls
 - ▶ Industrial motors and adjustable speed drives
 - ▶ Lighting

3.2 ACTUAL MARKET VS POTENTIAL MARKET

Many of the most frequently used methodologies for estimating market size depend heavily on assessing the market as measured by “market potential.” This can be defined as technological possibilities or levels of anticipated energy savings. Unfortunately, these methodologies produce statistics that are frequently several orders of magnitude higher than actual market size as represented by current product sales. They incorporate nested assumptions about the future, such as growth rates, penetration rates, government policies, and manufacturer interest. These estimates of future market potential often focus on the size of the market that would be possible in an *ideal* world, instead of what is likely to occur in the *real* world. The large gap between actual market size and market potential estimates severely limits the usefulness of the latter.

Instead of attempting to predict the future market potential for energy-efficient products, this report focuses on providing estimates of the market size based upon current and future product sales. In most cases, estimates of future sales are closely correlated with prevailing growth rates in regional and technology markets in general. Penetration rates, manufacturer interest, and other parameters must also be estimated, but assumptions are more realistic and conservative than those that might be appropriate under the very best conditions. In the policy section of this report, we discuss policies and recommendations which could move the market from its predicted actual level towards a more robust potential level.

This chapter provides estimates of the actual aggregated energy efficiency market for developing countries and emerging market economies between now and 2015. More detailed market estimates for specific products and services are presented in Appendix A. The next section describes the assumptions regarding market behavior and market growth that were used in making these estimates.

3.3 MARKET BEHAVIOR AND GROWTH ASSUMPTIONS

The baseline data used to develop the estimates of the size of the energy efficiency market in developing countries came from 1993 U.S. Department of Commerce import statistics, adjusted for 1996. The statistics are derived using Standard International Trade Classification (SITC) codes, which were categorized by individual product and technology components. The 1993 statistics were adjusted for 1996 based on the rate of GDP growth in each country, with some differentiation based on an assumed ratio of imports to domestic production of energy-efficient products. For more detail on the ratio used for each country, see Appendix A. This ratio was then used to extrapolate the size of the overall market within a given country. Ratios differed slightly by country, based on our general knowledge about the maturity of domestic technological production in individual countries. The 1996 figures approximate the actual size of the market for energy efficiency products and services in developing countries in that year.

The main reason for electing to use import statistics to estimate market size was their widespread availability across technology and regional categories. Because they are collected using the same methodology for all countries, these figures do not suffer from the classic “apples and oranges” problem the way most other industry or regional statistics would. In addition, estimates can easily be updated as soon as new annual statistics become available.

However, there are several limitations to relying upon import statistics as a basis for determining market size. First, there is the possibility that a product or technology is undercounted. For example, export manifests may not have been filled for individual sub-assemblies or components, thereby undercounting the export of certain energy-efficient technologies. Second, import categories established under the SITC system are not always exact matches for energy-efficient products. As a result, the statistics may record a furnace unit export, but not the fact that an energy-efficient motor is also included in an export transaction. Thus, a category may include items that are not necessarily energy-efficient while missing other items that are energy-efficient. Third, import statistics do not reveal the value of goods that are imported as component parts but subsequently re-exported as a component of finished goods, thereby never entering the domestic market. Despite these limitations, import statistics were used, being the most reliable figures available.

To project the likely size of the actual market in 2015, estimates were developed based on two scenarios: the conservative growth scenario producing a low estimate and the aggressive growth scenario producing a high estimate. The actual market size for 2015 would be likely to fall somewhere between the two.

Conservative growth scenario This scenario used prevailing economic growth rates (based on historical GDP) to make straight line projections for market size in 2015. As with the 1996 estimates, some secondary differentiation was made based on a ratio of the likely level of domestic manufacturing capability for energy-efficient products in each country.

Aggressive growth scenario For many countries and technology markets, however, the energy efficiency market will likely grow faster than the economy (approximated by GDP growth). Thus, an aggressive growth scenario was developed using a variety of industry data sources, including manufacturer sales statistics, telephone interviews with manufacturer representatives, other business focus series reports, Economist Intelligence Unit data, as well as Hagler Bailly proprietary information. Average annual rates of growth were projected for two different periods: 1996-2000 and 2001-2015. The assumption was that market growth in most countries and for most market segments would be higher in the first period and slow slightly in the second period, primarily because of increased market penetration. Projections of market growth for each technology were based partially on historical growth rates. Historical economic data by country and region was drawn from published figures of the International Energy Agency. Long-term projections for economic growth, used mainly for the second period (2001-2015) were based on the WEFA Group's *Ranking of the World Economies by Size: Comparative Analysis of World GDP and Consumption Expenditure*.

Market penetration rates were developed based on discussions with multinational manufacturers who produce both energy-efficient and standard technologies and market them in the individual countries. In most cases, the estimates came from manufacturers' representatives in individual countries familiar with

markets there. Additional data were drawn from published market data, including Department of Commerce market research reports, country energy efficiency market assessment reports, and utility-led demand side management studies. Other information came from interviews with individuals familiar with the energy efficiency programs and potential within particular countries.

3.4 MARKET OVERVIEW

This report estimates that in 1996 the market for energy-efficient products and services in developing and emerging market countries had already reached \$9.5 billion. Under the aggressive growth scenario, the overall market for energy-efficient technologies in developing and emerging market countries is forecast to grow 11% per year from 1997 through 2015, causing the market to double approximately every seven years. This means that the developing and emerging market countries could represent a market of \$66.7 billion by 2015. Even under the conservative growth scenario, the market in developing countries can be expected to triple (to \$30.7 billion) by 2015. A summary of key market data is provided in Figure 5 and will be discussed in more detail in the next several sections. A complete set of data and assumptions is available in Appendix A.

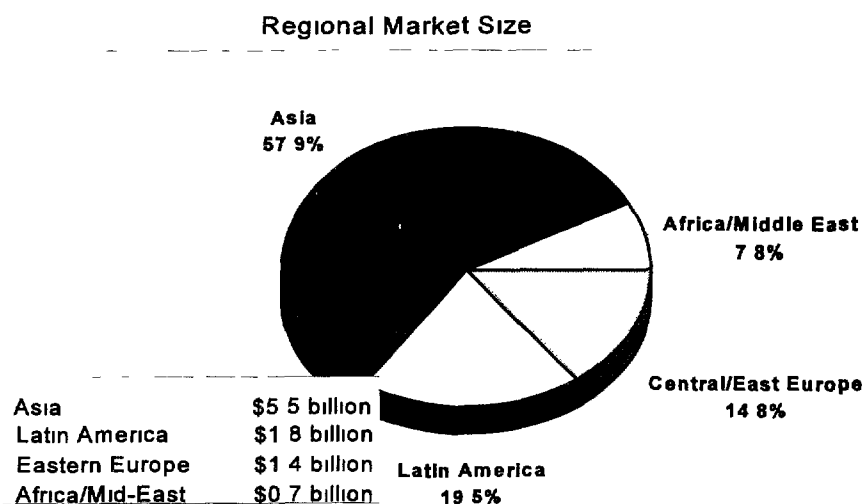
Figure 5 Market Summary			
Item	1996	2015 (conservative)	2015 (aggressive)
Market Size	\$9.5 billion	\$30.7 billion	\$66.7 billion
Largest regional market	Asia	Asia	Asia
Largest country market	China	China	China
Largest market segment	Process controls	Process Controls	Lighting
Fastest growing region	Asia	Asia	Asia
Fastest growing technology market	Motors	Motors	Lighting
Largest technology market			
Overall	Building Envelope	Process Controls	ASDs
Asia	Building Envelope	Building Envelope	ASDs
Africa/Middle East	Building Envelope	Building Envelope	Building Controls
Eastern Europe	Lighting	Lighting	ASDs
Latin America	Process Controls	Process Controls	Lighting

Source: Hagler Bailly, Inc.

3.5 REGIONAL MARKET OVERVIEW

Asia was the largest regional market by dollar amount in 1996, accounting for 58% of the total market for energy-efficient products and services. The markets for energy efficiency in the other three regions were notably smaller. Africa was the smallest market, with a share of only 8%. The Latin American market accounted for 20% and Eastern Europe accounted for 15% of the overall market. Figure 6 breaks down the total actual energy efficiency market by region for 1996.

Figure 6 1996 Energy Efficiency Market



Source: Hagler Bailly Inc.

The three largest country markets in 1996 were China, South Korea and Brazil. China was the largest single country market for all types of energy-efficient products and therefore contributed significantly to Asia's sizable market share. The Chinese market for energy-efficient products was close to \$1.3 billion, or 14% of the total energy efficiency market in 1996, and about 25% of the Asian market.

Figure 7 2015 Energy Efficiency Market

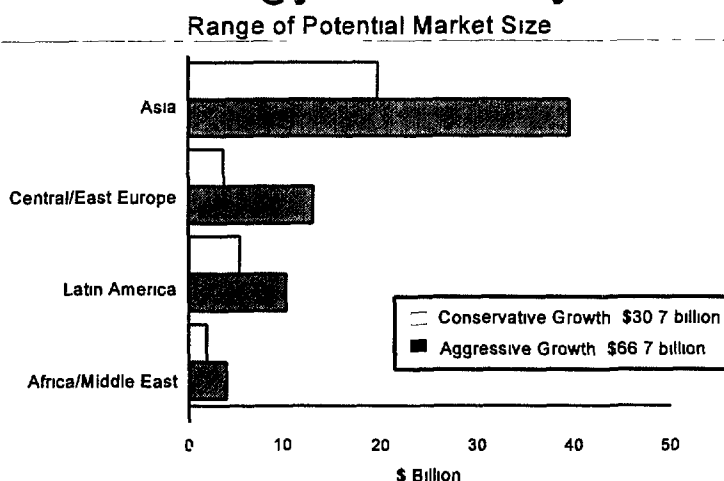


Figure 7 summarizes the projections of actual market size by region in 2015, using both the conservative growth scenario and the aggressive growth scenario. In the conservative scenario, Asia will remain the largest market, with a 64% share. Latin America will be second with 17%, followed by Central/Eastern Europe and Africa with 12% and 6%, respectively. Under the aggressive growth scenario, Asia will again be the largest market, comprising 59%, while Central and Eastern will eclipse Latin

Source: Hagler Bailly Inc.

America for second place, with 19% Latin American and Africa/Middle East will follow with 15% and 6%, respectively

Under both scenarios, China and South Korea are likely to remain the largest individual country markets, together comprising 32% of the total developing country market under both the conservative growth and aggressive growth scenarios for 2015 Under the conservative growth scenario, Mexico will remain in third place, while with aggressive growth, Russia will become the third largest country market, comprising 8% of the total market This is because under the aggressive growth scenario, Central/Eastern European economies will grow at a faster rate than Latin America during the next 15 years, expanding by 12% annually compared to Latin America's 9% Africa and the Middle East growth rates under the aggressive market growth scenario will be 9% per year, while Asia will continue to grow quickly at 11% annually

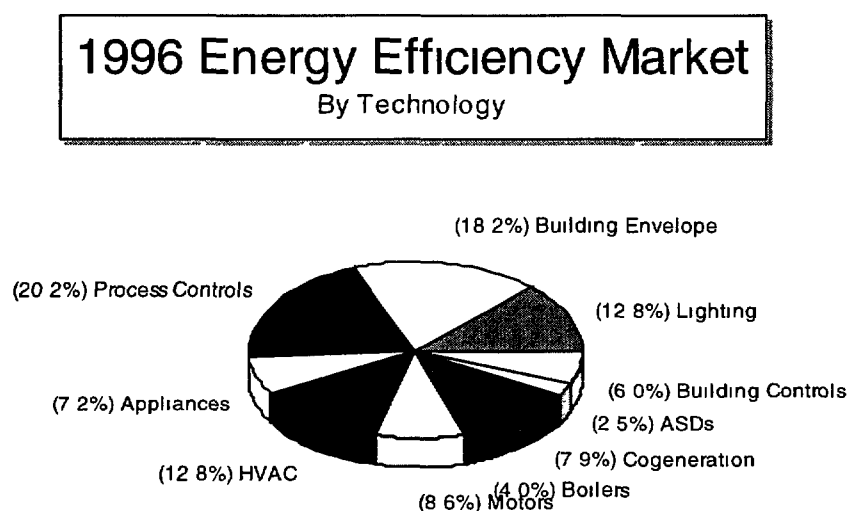
3.6 TECHNOLOGY MARKET OVERVIEW

Sizable markets exist in developing countries for process controls, HVAC, lighting, and building envelope technologies Other technologies form a smaller portion of the market Figure 8 summarizes the individual technology markets for energy efficiency in 1996

The process controls market alone accounted for 20% of the total energy efficiency market in 1996 Some of the technologies in this category include drying and evaporation, combustion, and compression systems The large market share of process controls is not surprising, since energy-intensive industries, common in many developing countries, are likely to become major consumers of process controls (e.g., cement plants,

foundries, steel manufacturing plants) Initiatives for privatization and modernization also fuel the market for process controls In addition, the cost of process control technology has fallen dramatically in recent years, making it more affordable for many customers in developing

Figure 8



Source Hagler Bailly Inc

countries. Nonetheless, it still remains an expensive technology, which contributes to its large share of the market as measured in dollars.

Building envelope was another large segment of the market in 1996, comprising a little over 18%. Technologies in this category primarily include insulation and glazed windows. The size of this technology market is largely due to Asia's prominence in the market, where large economic growth rates across

the board are fueling the need for fast-paced new building construction. The construction sector is struggling to keep up with the pace of population, commercial and industrial growth, and demand for business office space, hotels, shopping centers, hospitals, and schools is high throughout the developing world. Other than in Asia, however, building envelope technologies currently have a fairly low penetration rate.

Figure 9
2015 Energy Efficiency Market
By Technology

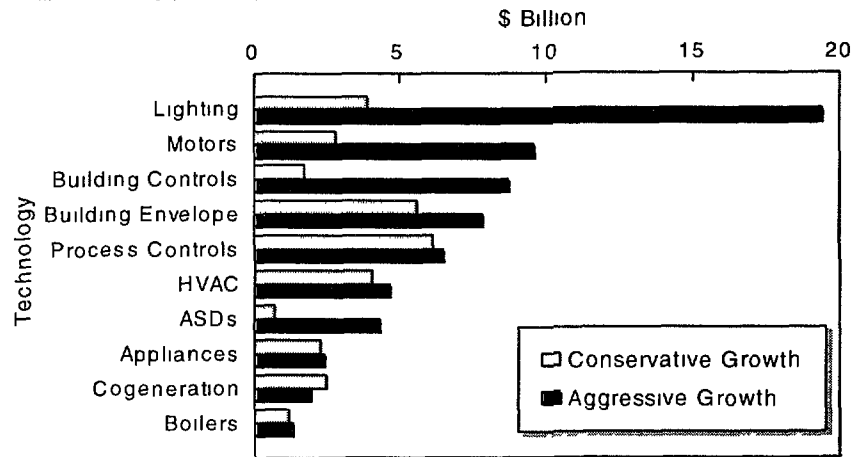
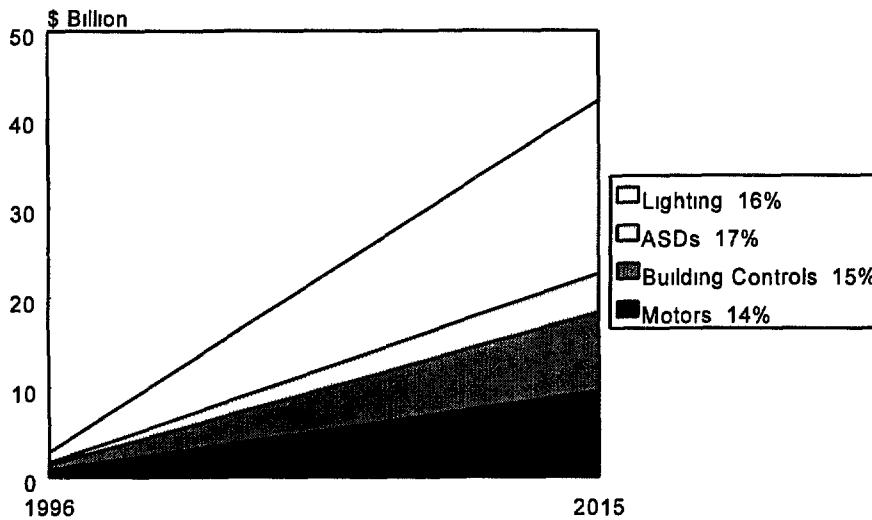


Figure 10

Fastest Growing Technology Markets



Source: Hagler Bailly, Inc.

This is at least partly due to a general lack of awareness of the benefits of building envelope technologies. A major barrier to market penetration for insulation, in particular, is that it is perceived as something that keeps buildings warm, such that people in warmer climates do not view it as a need. There is little understanding that insulation can also keep buildings cool.

The third and fourth largest technology markets in 1996 were lighting and HVAC, both estimated at roughly

\$1.2 billion, or 13% of the market. Both technology segments owe their market size in dollars to the sheer volume of sales.

Turning to the market projections for 2015, Figure 9 summarizes the market size estimations under both the conservative and aggressive growth scenarios. Under the conservative growth scenario, which assumes growth rates at or near GDP, overall annual growth over the next two decades will be at around 6%. Slight variations in growth rates among different technologies occur because of differences in penetration rate or regional market size assumptions. Under the aggressive growth scenario, however, projected growth rates vary considerably. Table 1 summarizes the projections under both scenarios.

Under the aggressive growth scenario, the fastest growing technology markets over the next two decades, in general, are likely to be motors, building controls, adjustable speed drives and lighting. Figure 10 illustrates the predicted explosive growth of these four segments in the near future. The current share of the overall market for these four technologies in 1996 is 30%. By 2015 these same four segments will account for 63% of the total market as illustrated in Figure 10.

Technology	1996 (\$Million)	2015					
		Conservative Growth Scenario			Aggressive Growth Scenario		
		Market (\$ Million)	Annual Growth (%)	% of Total	Market (\$Million)	Annual Growth (%)	% of Total
Lighting	\$1,213	\$3,865	6	13	\$19,414	16	29
Motors	\$812	\$2,793	7	9	\$9,578	14	14
Building Controls	\$572	\$1,690	6	6	\$8,736	15	13
Building Envelope	\$1,723	\$5,574	6	18	\$7,797	8	12
Process Controls	\$1,912	\$6,152	6	20	\$6,475	7	10
HVAC	\$1,211	\$4,044	7	13	\$4,644	7	7
ASDs	\$234	\$681	6	2	\$4,330	17	6
Appliances	\$679	\$2,260	7	7	\$2,431	7	4
Cogeneration	\$750	\$2,446	6	8	\$1,931	5	3
Boilers	\$377	\$1,192	6	4	\$1,351	7	2
Total Market	\$9,483	\$30,697	6		\$66,687	11	

Source: Hagler Bailly Inc.

Under the aggressive growth scenario, lighting is projected to be the largest technology market (29% by 2015), with an average annual growth rate of 16%. This is primarily due to the ease with which lighting penetrates developing country markets. Many energy efficiency and demand-side management (DSM) programs have already been implemented to target lighting in developing countries.

It is expected that this trend will continue well into the next century. In addition, lighting is fairly easy to market because of widespread understanding and appreciation of its uses and the collection of products and systems it represents.

Adjustable speed drives are expected to show the most remarkable growth. Although they were the smallest market segment in 1996, an average annual growth rate of close to 17% will cause this technology market to overtake the markets for boilers, appliances, and cogeneration by 2015. This high growth rate is expected because ASDs are a fairly new technology in the market. They regulate a motor's speed, start-up and torque. Since the use of motors is widespread in industrial, commercial, and residential applications all over the world, ASDs are projected to become increasingly prevalent in conjunction with motor use. The growth and penetration rate will be much higher than that of motors because current penetration is significantly lower than for motors in developing countries. The building control and motors markets are expected to grow at 15% and 14% annually, respectively, over the next two decades.

Process controls, on the other hand, are expected to go from being the largest technology market in 1996 to ranking fifth by 2015. This is primarily due to the decreasing price of these technologies over the long term. While they are currently enjoying greater penetration in the developing country market, this is expected to slow after approximately 2000 as markets become saturated. In addition, process controls have relatively long life cycles, requiring only infrequent replacement.

Cogeneration, boilers, appliances and HVAC are also projected to have relatively low annual growth rates under the aggressive growth scenario. Cogeneration is the lowest, at around 5%, which is actually substantially lower than its projected growth rate under the conservative growth scenario (6%). This is primarily due to the relatively high investment cost associated with cogeneration technologies, as well as the assumption that as other energy-efficient technologies penetrate the market, the economic attractiveness of cogeneration projects will decrease.

3.7 REGIONAL TECHNOLOGY MARKETS

When the data obtained about regional markets is cross-referenced with that of the technology markets, the picture of the developing country market for energy-efficient technologies becomes complete. Table 2 presents the top ten country technology markets in 2015 under the aggressive growth scenario. According to this analysis, these ten markets alone will account for 27% of the developing country market for energy-efficient technologies in 2015.

China merits attention as the most populous developing country in the world and is thus a huge potential market for energy-efficient technologies. The largest market segments in China are for efficient lighting and HVAC systems, primarily due to the building boom currently taking place in Southern China. Add to this the massive lighting market of Hong Kong (which became part of China in the summer of 1997) and the largest single potential focus for energy-efficient technologies emerges.

South Korea's total market for energy efficiency was an estimated \$1 billion in 1996 and could grow to as high as \$7 billion per year by 2015. Motors and building controls dominate South Korea's energy efficiency markets. The same is true for Russia and Poland, which emerge as the largest potential markets for energy efficiency in Eastern Europe. In Russia, other large emerging markets include building envelope

Rank	Country	Technology	Estimated Market Size (\$ Million)
1	Hong Kong	Lighting	\$4,717
2	South Korea	Motors	\$2,380
3	China	Lighting	\$1,782
4	Singapore	Lighting	\$1,393
5	South Korea	Building Controls	\$1,356
6	Taiwan	Lighting	\$1,328
7	China	HVAC	\$1,274
8	Russia	Building Controls	\$1,220
9	Russia	Lighting	\$1,210
10	Poland	Lighting	\$1,110
Total			\$17,770
Percentage of Developing Country Market in 2015			27%

Source: Hagler Bailly Inc.

(\$691 million) and process controls (\$347 million). In Poland, building controls will be a large potential market (\$843 million).

In Latin America, Brazil's building envelope market ranks 13th, with an estimated \$932 million by 2015. Brazil will also have relatively large markets for lighting (\$571 million) and industrial process controls (\$622 million), as well as building controls (\$481 million). Mexico is also projected to play a large role, with substantial markets estimated for lighting (\$704 million), motors (\$566 million), and process controls (\$420 million).

By contrast, the potential market in the Middle East and Africa in 2015 under the aggressive growth scenario is relatively small. The only markets estimated to cross the \$100 million mark annually are in Turkey (building controls, \$135 million, process controls, \$117 million, and building envelope, \$106 million), Saudi Arabia (lighting, \$127 million), and Iran (motors, \$123 million).

Another way to approach the analysis is to look at the countries or regions with the highest expected growth rates. Table 3 gives the projected growth rates by technology and region. This information may be

useful for manufacturers who want to expand their international markets and are looking for the areas for most promising growth in the near future. For example, a manufacturer of adjustable speed drives would want to concentrate on Eastern Europe (with a growth rate of 19% annually), while the best bet for lighting manufacturers is in Latin America (17% annual growth rate).

Technology	Region				Total
	Africa/Mid East	Asia	Eastern Europe	Latin America	
ASDs	15%	16%	19%	16%	17%
Lighting	14%	16%	15%	17%	16%
Building Controls	15%	15%	17%	14%	15%
Motors	15%	14%	11%	14%	14%
Building Envelope	7%	7%	14%	9%	8%
HVAC	6%	8%	6%	6%	7%
Boilers	7%	7%	6%	9%	7%
Appliances	6%	8%	6%	6%	7%
Process Controls	7%	7%	6%	6%	7%
Cogeneration	9%	5%	4%	6%	5%
Overall	9%	11%	12%	9%	

Source: Hagler Bailly Inc.

3.8 MARKET ORGANIZATION

Increasingly, manufacturing of energy efficiency products is dominated by a small number of large multinational corporations. Industries are consolidating as smaller, local firms are acquired or rendered uncompetitive. The consolidation within technology markets is partly due to two main factors: the need to keep costs down by achieving economies of scale and acquisitions of local firms by multinationals seeking a foothold in new markets.

Multinational firms dominate the market in six of the ten technology segments analyzed for this report. The number of firms active in each of the technology markets ranges from three to no more than seven manufacturers (see Figure 11). Although research for this report did not compile quantitative data about individual manufacturer market share, the small number of firms in each technology market illustrates this point. The firms listed in Figure 11 account for over 90% of the sales of efficient technologies in the developing world. Overall, production by U.S.-owned companies is projected to be able to meet only 10-12% of the demand for these technologies by 2015. Two technology markets, residential appliances and

Figure 11
MULTINATIONALS BY
MARKET SEGMENT
 (in decreasing order of annual sales)

Industrial Process Controls

Asea Brown Boveri (ABB)
 General Electric
 Honeywell (and Yamatake Honeywell)
 Siemens
 Yokogawa Electric Corporation
 Siebe Environmental Controls
 Landis & Gyr

Building Controls

Siebe Environmental Controls
 Johnson Controls
 Honeywell (and Yamatake Honeywell)
 Landis & Gyr
 Siemens

Building Insulation

Saint Gobain
 Owens Corning Fiberglass
 Schuller International

Boilers

ABB
 Mitsubishi Heavy Industries
 Babcock & Wilcox
 Foster Wheeler
 Deutsche Babcock
 Mitsui Babcock Energy

Appliances

Siemens
 Electrolux
 Whirlpool
 General Electric Appliances
 Maytag Corporation
 Raytheon

Lighting

General Electric Lighting
 OSRAM GmbH
 Philips Lighting

Motors

ABB
 General Electric
 Mitsubishi
 Reliance
 Siemens
 Sumitomo
 Toshiba

Source: Company annual reports

lighting, are discussed below to highlight the dominance of multinational manufacturing companies producing energy-efficient technologies

Efficient residential appliances There are six firms that account for the majority of the global efficient residential appliance market. In total they manufacture approximately 35 brand name appliances. Raytheon Corporation sells its appliances under eight different brand names, while Whirlpool and Maytag each market six brands. Recent corporate acquisitions in the appliance industry include Whirlpool's purchase of Philips' major home appliance business, Siemens' purchase of Bosch, and Electrolux' takeover of Frigidaire. Local companies with small distribution and low costs still remain key to developing country markets, but this is beginning to change as the giant multinational competitors turn their focus in this direction.

Efficient lighting The three largest lighting manufacturers are Osram GmbH, GE Lighting, and Philips Lighting. Each company has a global presence and is currently expanding its international operations. For example, Osram GmbH, the lighting division of Germany's Siemens, is one of the leading manufacturers of lighting products in Europe, Latin America, Japan, and several Asian countries. In 1993 Osram acquired U.S.-based Sylvania to gain an even stronger presence in the Western Hemisphere. Osram plans to open between eight and ten plants in Asia by 2000 to take advantage of lower production costs. The company completed a new manufacturing plant in China in 1996 and is currently negotiating for a production site in Indonesia. They are also expanding distribution in Eastern Europe and Latin America.

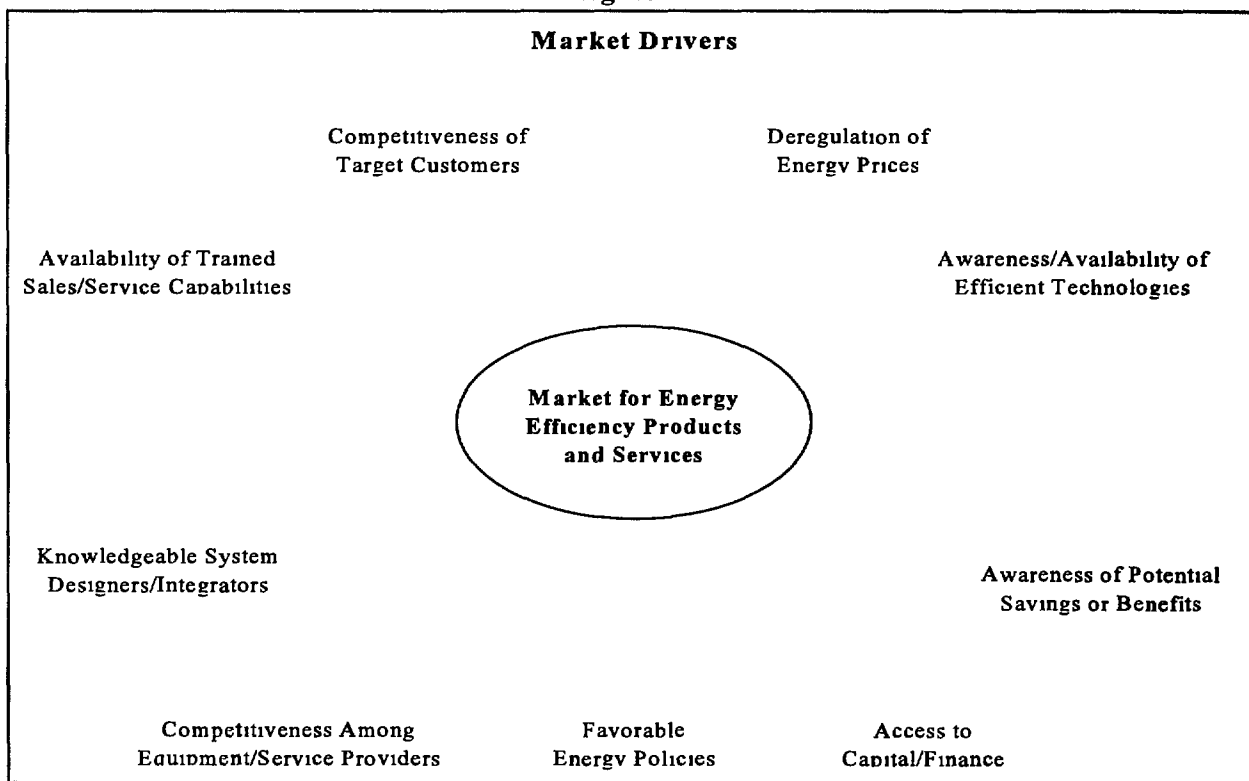
GE Lighting also has offices throughout the world. The company has made a significant investment in the Hungarian lighting firm Tungsram, whose Nagykanisza plant is the sole producer of GE's compact fluorescent technology. GE Lighting also has joint ventures in Asia.

4. MAJOR POLICY ISSUES AND IMPLICATIONS

After examining the market data and trends presented in the preceding chapters, one primary conclusion is apparent the market for energy efficiency technologies in developing countries is growing, but there is still a need to support and nurture the market. Multilateral development agencies, developing country policy makers, and technology manufacturers must continue efforts to transform foster and channel assistance to the energy efficiency market. The challenge will come not in creating an energy efficiency market, but in utilizing the market already in existence for the largest possible gains in actual energy efficiency savings.

In order to influence the energy efficiency market, policy makers in both developing countries and multilateral organizations must first understand how the market works. For example, the potential drivers in the energy efficiency market are numerous. Figure 12 gives a graphical representation of these drivers, which generally fall into three distinct categories: financial (access to capital, competitiveness of target customers, and deregulation of energy prices), technical (availability of trained sales/service personnel, knowledgeable system designers/integrators, and awareness/availability of efficient technologies), and social (awareness of potential savings or benefits, competitiveness among equipment/service providers, and favorable energy policies).

Figure 12



knowledgeable system designers/integrators, and awareness and availability of efficient technologies), and social (competitiveness among equipment/service providers, awareness of potential savings or benefits, and favorable energy policies) Understanding how these factors work together to influence the energy efficiency market should be the highest priority for anyone desiring to take part in this market

Beyond the conceptual framework shown in Figure 12, policy makers need to have information about *what* technologies are being sold, *where* large markets exist, *who* is buying energy-efficient technology, and *why* they are doing so Once they have developed an understanding of the market, they can begin to design and implement policies aimed at meeting the needs of that growing market

4.1 KEY ISSUES

A key issue for policy makers today is the need to recalibrate their policies to the realities of today's market Instead of trying to *lead* the market, as was the priority in the past, policy now must focus on *following* the market by recognizing private sector interests and working with them to remove any additional barriers that still exist Market demand is beginning to pull policy along, rather than policy pushing the market

Rapid growth requires action now, to avoid future lost opportunities for energy efficiency In many countries, economic and population growth are contributing to the need for more buildings, more products, and more electricity, among numerous other requirements Thousands of new businesses are founded each year and new buildings are being erected almost daily (See Chapter 2 of this report for a more detailed discussion of construction trends) In this era of fast growth, especially of industries and building stock, failure to incorporate energy-efficient design into these facilities now will result in tremendous lost opportunities for energy efficiency in the future Once an energy efficiency measure is installed, it continues saving energy throughout its usable life

Special attention should be paid to policies targeted specifically at new construction Virtually all of the technology markets discussed in this report will grow in tandem with a country's economy The construction boom will further drive certain technology markets, in particular the markets for building envelopes, building controls, HVAC, appliances boilers and lighting in all sectors These technologies together account for 66% of the expected market for energy-efficient technologies in developing countries in 2015 Because of the emphasis on new construction, the retrofit market will likely account for just a small portion of this demand Taking the effort now to establish building efficiency standards will ensure that new buildings incorporate energy-efficient designs creating benefits far into the future Conversely, failure to incorporate energy efficiency measures in new construction will mean more costly retrofits in the future Only Eastern Europe has a significant retrofit market today, because of infrastructure investments made under socialist economic systems In Asia and Latin America, the emphasis is firmly on new construction

Awareness-building will continue to be a key aspect of any successful policy One of the most important ways energy-efficient technologies can be promoted is by educating stakeholders in developing countries

about energy efficiency. International expertise often is required to bring local engineers and designers up to date on the most efficient technologies available. International agencies and governments can aid in the transfer of this experience base, as they have in the past. Those who need accurate and current information on efficient technologies include architects and engineers designing new buildings, commercial building managers, industrial managers, utility personnel, policy makers, and the finance and investment community.

Modern information technologies such as facsimile machines, high speed phone lines, and Internet sites (world wide web, ftp, and gopher) are new vehicles for fostering information exchange. More traditional education and training programs include study tours to industrialized countries, certification programs for technicians, leadership and technical training seminars and workshops. Although it is difficult to assess the impact of such programs in terms of actual energy saved, these activities can be extremely valuable.

The need to address global climate change issues suggests that international donor assistance should be shifted to newly industrialized countries and other primary GHG emitters. At present, a mismatch exists between countries that are given priority for international development assistance and countries with the greatest potential for GHG reduction and climate change mitigation. Donor agencies should consider that poor agrarian societies are not the only ones needing development assistance. Many newly industrialized countries have great need of assistance in the area of energy efficiency. These include the 'tigers' of Asia, where as much as 85% of the infrastructure that is likely to be in place by 2015 has not even been built yet. A more detailed discussion of regional and technological growth is provided in sections 4.2 and 4.3.

Improved coordination between and among nations will increase the leverage of energy efficiency organizations and agencies, and their ability to promote energy efficiency on numerous levels. Bi-national and international coordination can improve countries' abilities to direct and control the development of energy efficiency markets without weakening market incentives for multinational companies. Globalization has already stimulated coordination among nations in the areas of international trade and financial markets, this coordination should be extended to the area of energy efficiency. The prominence of multinational manufacturers in the energy efficiency market increases the importance of cooperative efforts among countries for market policy initiatives.

4.2 INFLUENCE OF REGIONAL TRENDS

Extensive country-specific quantitative data on market barriers were not collected for this report. Through conversations with manufacturers, interviews with in-country experts, and general consideration of the market contexts, however, the authors formulated qualitative observations about the potential for overcoming market barriers in each of the main geographic regions. Table 4 presents an assessment of the relative magnitude of the barriers to be overcome in each region. In general, each geographic region will require a distinct policy strategy which takes into account not only the potential size of the energy efficiency market there, but also the potential barriers and likely strategies for overcoming them.

Table 4
Overall Market Potential by Region
(Aggressive Growth Scenario)

Indicator	Africa/Middle East	Asia	Eastern Europe	Latin America
Market Size Potential				
2015 Market Size (million US\$)	\$3,895	\$39 602	\$12 988	\$10 202
Relative Size Potential	▲	■	●	●
Potential for Overcoming Barriers				
Financial	▲	■	▲	●
Technical	▲	■	●	●
Social	▲	●	●	●
OVERALL POTENTIAL	LOW	HIGH	MEDIUM	MEDIUM
Legend ▲ Low ● Medium ■ High				

Source Hagler Bailly Inc 1997

Asia Financial barriers in general tend to be quite low in Asia, due to growing foreign investment, rapid economic growth, and a generally rising standard of living among most of the population. Regional variations exist, of course, with countries like India and China experiencing high economic growth rates, and countries such as Thailand, Indonesia and Malaysia struggling with the recent economic downturn and currency devaluations. Technical barriers in Asia also tend to be generally low, because of the presence of a well-educated population and large numbers of architects and engineers who have been trained abroad in the latest building and design techniques. Asia needs outside assistance in the area of social barriers, however. Knowledge of the benefits of energy-efficient technologies and energy conservation in general is low among the populations of Asian countries. Still, the sheer size of the potential market for energy-efficient technologies in Asia over the next two decades makes it the highest priority for assistance. The huge potential impact that energy-efficient technologies would have, combined with the relatively low barriers, makes Asia the most attractive region for energy efficiency attention by international development agencies.

Eastern Europe The most significant barriers in this region are financial. Most countries in the region face major scarcity of capital for investment in energy efficiency. With the collapse of the command-and-control approach of the socialist economic system, most countries are struggling economically. In the technical and social areas, the prospects are somewhat better. Engineering and technical skills within the populations are well-developed, and the interdependence of countries in the region with regard to energy resources would allow for a well-designed regional program. Because of the large amount of existing infrastructure, Eastern Europe promises to be a large market for energy-efficient technologies through 2015, especially as industries modernize and update their existing equipment.

Latin America Several Latin American countries including Mexico, Brazil and Argentina are already giving a lot of attention to energy efficiency issues through the sponsorship of USAID and other donor agencies. This creates some degree of awareness in the population. Technical and financial barriers are higher in some countries than others, but the generally robust growth expected in the market for energy-efficient technologies suggests that targeted policies could produce substantial results over the next 20 years.

Africa and the Middle East In general, all types of barriers are quite high in Africa and the Middle East. Capital is scarce throughout the region, except in certain oil-rich countries. Educational levels are low, creating both technical barriers (lack of trained engineers and design specialists) and social barriers (lack of awareness of the benefits of energy efficiency). Government policies are not well-developed in the energy area. The nature of these barriers, coupled with the small projected size of the energy-efficiency market through 2015, makes Africa and the Middle East the lowest priority for international donor agency attention in the area of energy efficiency.

These regional generalizations are useful for determining which regions should be targeted for more attention and assistance in the near future.

4.3 INFLUENCE OF MARKET CHARACTERISTICS AND TRENDS

Several market characteristics and market trends suggest that new approaches to stimulating energy efficiency markets are needed.

Market aggregation is needed to overcome the fragmented nature of the market for energy-efficient products As was mentioned previously, the energy efficiency market includes a number of product segments, including large capital goods, residential appliances, and building materials, in addition to engineering and other services. Moreover, energy-efficient products do not comprise entire product segments, but are only subsets of these segments. Market players are diverse and include many small players with minimal amounts of investment capital. An approach that aggregates the market creates larger targets for investment capital. Smaller and less organized consumers are unlikely to be able to tap private capital markets as successfully.

Programmatic approaches can increase the influence of policy makers on the energy efficiency market In the past, donor agencies have tended to provide assistance to discrete projects. This approach is time and labor intensive and can influence only a small portion of the market. Although there will always be a need for project-specific assistance, a programmatic approach can increase the portion of the market that benefits from donor assistance. A programmatic approach would bundle several energy efficiency projects. The advantages of this approach are 1) a single source of capital can be tapped to finance all of the projects, 2) an equipment vendor might find the larger bundle of projects more attractive than a single purchaser, and 3) the time and labor that would be needed to provide assistance to a program can be shared among all the projects, reducing the per-project transaction costs.

Establishing efficiency standards and building energy codes can have a significant impact on the development of markets for energy-efficient products and services In developing countries, the energy efficiency market is growing fastest in those technologies that are most amenable to achieving efficiency gains through standards. By 2015, lighting, adjustable speed drives, building controls and motors will make up approximately 63% of the energy efficiency market in these countries. Standards insert a floor on the energy consuming levels of appliance and buildings. They will account for a greater portion of the efficiency gains that will occur as technology markets grow. Particular attention should be focused on Asia, where the most rapid growth is occurring. An international cooperative agency for energy efficiency and global climate change could help focus this attention most effectively.

Explicit government policies that establish codes or standards can effectively address market failures or market imperfections. By establishing minimum efficiency standards or building energy codes, governments are effectively defining the market to include only those products that meet the standards (or that allow a building to satisfy energy codes). Some products will fall out of the market because by definition they are not efficient. New products may also enter the market because their comparative advantage has improved as a result of the new standards. Rapid economic growth in developing countries is fueling high growth in sales of household appliances and commercial and industrial equipment. Efficiency standards, if introduced, would ensure increased market share for higher-efficiency products.

The use of labeling and standards is still relatively rare in the developing world. A recent USAID-sponsored report summarizes the status of labeling programs, building codes and efficiency standards around the world.¹¹ Out of approximately 180 countries, eleven countries and the European Union have energy labeling programs. Nine countries have efficiency standards for household appliances. Six countries have efficiency standards for industrial and commercial equipment. Forty-four countries have building codes for residential, non-residential or both types of buildings.

Given the relative scarcity of standards in developing countries, their impact on energy efficiency markets is currently quite small. But over the long term, the sales impact of standards introduced now could be quite substantial. Preliminary estimates of the potential market impact of establishing efficiency standards have been compiled for five countries: India, Indonesia, Philippines, Mexico, and Brazil.¹² The study estimated unit sales of energy-efficient products in each of the five countries ten years after the introduction of standards. For example, the study estimated that the introduction of standards would create a market for 106 million energy-efficient lamps in India, 41 million refrigerators in Brazil and 18 million fans in Indonesia.

Regional adoption of energy efficiency standards will further augment efficiency gains The best way to insure widespread support, not only from donor agencies but also from multinational companies selling efficient technologies, is to work toward regional efficiency standards. Donor agencies can help encourage,

¹¹Duffy John 1996 *Energy Labeling Standards and Building Codes: A Global Survey and Assessment for Selected Developing Countries*. Washington D C: GEEI/Publications. This publication was funded by the United States Agency for International Development.

¹²Ibid p. 57

develop and foster the implementation of efficiency standards. An international agency responsible for energy efficiency would have a strong influence on the creation of regional standards. Companies would be likely to support a regional approach to standards, especially if the alternative would be individual country standards. Regional application of standards would introduce economies of scale to manufacturing and reduce manufacturers' opposition to standards.

4.4 RECOMMENDED ACTION PLAN

The challenge for policy makers is to integrate the numerous issues raised above into a coherent action plan. Policy makers will need to prioritize the countries, regions, sectors and technologies needing assistance in order to maximize actual energy savings in the next few years. In this section, priorities are recommended for the short term (two years) and medium term (two to five years).

4.4.1 Short-term priorities

In the next two years, the greatest potential energy efficiency gains will come from focusing on Southeast Asia and the commercial and industrial growth occurring there. High rates of growth in this region and these technologies mean that more opportunities will be lost here than in any other area if action is not taken now. Specific countries warranting the most attention are Hong Kong (now part of China), Indonesia, South Korea, and Singapore. Crucial technology markets are lighting, building controls, and motors. Table 5 gives a summary of these markets and the barriers in each.

Asia's capital markets are relatively well-established so that access to capital should not be a significant barrier. Rapid economic growth will continue to lift consumers' income levels, making investments in energy efficiency more affordable. Awareness of energy efficiency is a barrier, both among tradespeople responsible for installing energy-efficient measures at commercial and industrial sites and among the general population. A sharply focused multi-media awareness campaign should be launched to overcome this barrier. Key regional institutes would act as "nodal agencies" for information collection, synthesis, and dissemination while also serving as a "one-stop shop" for implementing energy-efficiency programs primarily through establishing linkages between technology vendors and technology users.

Country/Technology	2015 Market Size Estimate (\$ml)	Growth Rate (%)	Barriers
Hong Kong	\$6 602	14.4	Awareness
Lighting	\$4 717	18.0	Awareness, Capability
Singapore	\$3 621	13.0	Awareness
Lighting	\$1 393	16.0	Awareness
Motors	\$1 033	15.0	Capability
Indonesia	\$3 156	10.6	Awareness
Building Controls	\$644	15.6	Capability
Motors	\$787	15.0	Awareness
South Korea	\$6 965	10.3	Awareness
Building Controls	\$1 356	15.6	Capability
Motors	\$2 380	13.9	Awareness

4.4.2 Medium-term priorities

Table 5 lists the countries meriting attention two to five years from now. These include China, Russia, and Brazil. These countries should experience relatively strong economic growth over the long term. China is a major contributor to greenhouse gas emissions, its energy consumption patterns warrant the concern of the international community.

The fastest growing technology markets in Brazil, China, and Russia are projected to be lighting, HVAC, building controls, and building envelope. In Russia, the size of the building controls market in particular, is due to significant building infrastructure already in existence. Since there is not expected to be a large amount of new construction in Russia over the next several years, attention to this market segment can safely be left to the medium-term, despite the high growth rates projected.

Lighting is projected to be an important technology in all three countries, as it is in most of the world due to widespread awareness of the technology, ease of installation and use, and relatively low cost. Lighting is also important in the medium-term due to its application in all sectors, including residential, industrial, and commercial. This cross-sectoral and cross-boundary appeal makes it an ideal technology to be promoted through an international climate change forum.

Country/Technology	2015 Market Size Estimate (\$ml)	Growth Rate (%)	Barriers
China-overall	\$7,545	9.8	Political
Lighting	\$1,782	18.0	None
HVAC	\$1,274	9.0	Cost, Capability
Russia-overall	\$5,925	12.8	Financial
Building Controls	\$1,220	16.9	Cost
Lighting	\$1,210	13.9	Awareness
Brazil-overall	\$3,242	9.0	Financial
Building Envelope	\$932	9.5	Cost
Lighting	\$571	16.0	Cost Awareness

Barriers in these markets that donor agencies and policy makers can help overcome fall mainly in the financial realm. The Russian economy is currently heavily capital-constrained. The absence of a reliable banking system makes borrowing money for investment in any of these technologies problematic. Financing programs and assistance from donor agencies can help alleviate much of the financial pressures holding back the Russian market.

In Brazil, cost is an issue. Such economic concepts as life-cycle costs are not widely understood by the general population. Levels of awareness in Brazil about energy-efficient technologies are also relatively low.

China is a huge potential market for almost all energy-efficient technologies. The main barriers in China are also social, including lack of awareness and technical training to deal with the technology installation and maintenance. Strategies for overcoming these barriers are often hampered by political constraints outside the energy efficiency markets. The World Bank and Asian Development Bank are active in the Chinese efficiency market, but United States and European efforts may be constrained by the political positions of their governments.

APPENDIX A

MARKET ESTIMATES

Total 1996 Energy Efficient Market	1
Total 2015 Energy Efficient Market - Aggressive Growth Scenario	2
Total 2015 Energy Efficient Market - Conservative Growth Scenario	3
Comparison of Energy Efficient Market to GDP	4
Economic Growth Past, Present, and Future	5
OECD Europe	6
OECD Pacific	7
US/Canada	8
Middle East/Africa	9
Asia/Pacific	10
Eastern Europe	11
Latin America	12
Energy Efficient Building Controls Market	13
Energy Efficient HVAC Market	14
Energy Efficient Building Envelope Market (Insulation and EE Windows)	15
Cogeneration Market (equipment only)	16
Energy Efficient Appliance Market	17
Energy Efficient Boiler Market	18
Process Controls Market	19
Energy Efficient Motor Market	20
Energy Efficient Adjustable Speed Drives Market	21
Energy Efficient Lighting Market	22

TOTAL 1996 ENERGY EFFICIENT MARKET

Region/Country	1996 Estimated Market \$ Million										TOTAL
	Lighting	Building Envelope	Process Controls	Appliances	HVAC	Motors	Boilers	Cogen	ASDs	Building Controls	
Africa/Middle East											
Algeria	2	24	5	3	6	2	7	0	0	6	53
Egypt	5	6	8	1	7	3	1	0	1	1	34
Iran	2	23	15	3	15	7	2	0	5	6	78
Israel	6	4	22	4	7	3	8	17	1	1	75
Kuwait	3	2	4	2	7	1	1	0	0	0	21
Morocco	1	4	6	1	5	1	28	0	0	1	49
Nigeria	2	2	4	2	3	1	0	0	0	1	15
Saudi Arabia	11	19	18	7	23	4	4	0	2	5	93
South Africa	4	10	12	3	16	3	3	0	1	2	54
Turkey	3	26	19	2	13	4	4	4	2	6	84
U A E	6	6	7	5	13	2	2	0	1	2	45
Sub Total	44	126	121	32	116	32	62	21	16	31	601
Region Total	55	158	151	40	145	40	77	27	16	31	739
Asia											
China	77	179	214	148	246	113	98	106	36	67	1 284
Hong Kong	203	81	46	68	41	28	4	0	10	30	512
India	130	128	101	29	10	7	2	29	2	48	486
Indonesia	15	111	123	22	26	55	19	39	11	41	463
Malaysia	29	29	48	5	19	18	4	0	4	11	167
Pakistan	11	18	8	3	6	5	1	0	1	7	61
Philippines	10	16	14	4	7	8	2	59	2	6	127
Singapore	83	23	91	10	40	73	6	0	20	9	354
South Korea	45	233	165	45	212	200	14	41	33	87	1 076
Taiwan	67	63	61	22	34	31	10	42	7	24	360
Thailand	29	43	25	44	66	34	10	80	5	16	351
Sub Total	698	924	895	400	708	572	170	396	130	346	5 239
Region Total	734	973	942	421	745	602	179	417	130	346	5 489
Central/East Europe											
Czech Republic	57	14	66	6	21	8	31	33	11	9	256
Hungary	48	18	15	5	10	10	11	17	9	12	154
Poland	56	60	26	15	25	6	26	21	7	40	282
Russia	102	95	114	4	38	46	15	21	35	63	533
Sub Total	262	186	222	29	94	71	83	92	63	125	1 225
Region Total	309	218	261	34	111	83	97	108	63	125	1 408
Latin America											
Argentina	15	60	12	30	21	3	3	29	1	13	187
Brazil	34	167	204	52	68	12	2	54	3	35	631
Chile	11	26	111	19	20	14	10	0	3	5	218
Colombia	3	5	10	4	6	3	1	14	1	1	48
Mexico	35	71	138	43	55	34	3	62	15	15	472
Venezuela	6	9	26	18	20	13	2	19	3	2	117
Sub Total	104	337	501	166	189	79	20	179	26	71	1 672
Region Total	116	374	557	185	210	88	22	199	26	71	1 847
TOTAL	1 213	1 723	1 912	679	1 211	812	377	750	234	572	9 483

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TOTAL 2015 ENERGY EFFICIENT MARKET - Aggressive Growth Scenario

Region/Country	2015 Estimated Market - \$ Million										TOTAL
	Lighting	Building Envelope	Process Controls	Appliances	HVAC	Motors	Boilers	Cogen	ASDs	Building Controls	
Africa/Middle East											
Algeria	8	60	10	6	14	4	18	0	1	51	171
Egypt	29	18	25	2	27	57	8	0	24	30	219
Iran	24	62	46	7	39	123	13	0	81	52	446
Israel	40	26	68	10	22	48	26	51	20	22	332
Kuwait	33	10	12	6	18	14	10	0	7	9	119
Morocco	16	24	18	4	16	18	72	0	5	20	193
Nigeria	20	6	23	4	7	6	1	0	3	5	75
Saudi Arabia	127	71	56	21	69	73	13	0	27	90	544
South Africa	44	24	76	8	41	17	7	0	7	20	245
Turkey	62	106	117	7	40	73	25	56	42	135	663
U A E	90	17	22	14	48	14	15	0	7	15	242
Sub Total	492	425	472	88	341	447	207	106	224	447	3 250
Region Total	616	531	590	110	426	559	259	133	224	447	3 895
Asia											
China	1 782	722	773	599	1 274	691	298	314	301	790	7 545
Hong Kong	4 717	293	168	274	125	476	11	0	233	304	6 602
India	797	449	368	101	30	81	8	112	27	744	2 717
Indonesia	210	448	446	79	135	787	79	116	212	644	3 156
Malaysia	406	118	175	16	75	303	16	0	99	170	1 380
Pakistan	228	65	31	11	23	24	7	0	7	67	462
Philippines	194	65	42	14	29	97	7	78	25	94	643
Singapore	1 393	95	329	40	173	1 033	34	0	387	136	3 621
South Korea	162	943	501	183	768	2 380	69	71	532	1 356	6 965
Taiwan	1 328	254	223	88	138	370	56	55	113	365	2 990
Thailand	212	173	75	180	285	405	55	182	75	248	1 888
Sub Total	11 428	3 625	3 131	1 586	3 055	6 648	639	928	2 010	4 919	37 968
Region Total	12 030	3 815	3 296	1 669	3 216	6 997	673	977	2 010	4 919	39 602
Central/East Europe											
Czech Republic	676	100	201	17	64	43	109	58	140	176	1 583
Hungary	954	91	47	14	30	117	32	19	269	210	1 784
Poland	1 110	364	96	45	77	86	78	41	259	843	2 999
Russia	1 210	691	347	10	116	552	45	80	1 024	1 220	5 295
Sub Total	3 950	1 246	691	86	286	798	265	198	1 693	2 448	11 661
Region Total	4 648	1 466	813	101	337	938	311	234	1 693	2 448	12 988
Latin America											
Argentina	297	305	44	84	65	52	17	112	20	158	1 153
Brazil	571	932	622	160	171	70	8	209	20	481	3 242
Chile	179	143	403	57	61	197	38	0	51	74	1 203
Colombia	41	17	29	10	14	21	3	42	7	9	193
Mexico	704	358	420	131	239	566	23	95	288	185	3 010
Venezuela	117	31	80	54	50	68	8	72	18	16	513
Sub Total	1 909	1 787	1 598	496	599	975	97	529	403	922	9 315
Region Total	2 121	1 985	1 775	551	666	1 083	108	588	403	922	10 202
TOTAL	19 414	7 797	6 475	2 431	4 644	9 578	1 351	1 931	4 330	8 736	66 687

TOTAL 2015 ENERGY EFFICIENT MARKET - Conservative Growth cenario

Region/Country	2015 Estimated Market - \$ Million										TOTAL
	Lighting	Building Envelope	Process Controls	Appliances	HVAC	Motors	Boilers	Cogen	ASDs*	Building Controls*	
Africa/Middle East											
Algeria	4	53	10	6	12	4	16	0			105
Egypt	10	13	18	2	16	7	2	0			68
Iran	6	52	35	6	35	17	5	0			156
Israel	14	10	58	10	19	9	22	44			186
Kuwait	8	4	11	6	20	2	3	0			54
Morocco	4	11	16	3	14	3	75	0			126
Nigeria	4	5	8	4	6	2	1	0			30
Saudi Arabia	26	48	45	17	56	11	10	0			213
South Africa	10	26	34	9	44	8	8	0			139
Turkey	9	77	56	6	38	11	12	12			221
U A E	18	18	21	14	39	7	7	0			124
Sub Total	113	317	312	83	299	81	160	56	0	0	1 421
Region Total	141	398	389	104	374	99	200	70	37	74	1 886
Asia											
China	298	694	830	576	956	439	380	412			4 585
Hong Kong	696	278	158	233	141	97	15	0			1 618
India	409	402	318	90	31	21	6	91			1 368
Indonesia	53	401	444	79	95	200	70	142			1 484
Malaysia	105	108	177	17	70	66	14	0			557
Pakistan	41	63	30	11	22	17	5	0			189
Philippines	33	55	48	13	24	28	6	202			409
Singapore	304	86	333	36	147	267	22	0			1 195
South Korea	165	860	606	167	782	735	53	151			3 519
Taiwan	242	227	221	79	123	112	35	151			1 190
Thailand	109	160	92	167	247	127	36	300			1 238
Sub Total	2 455	3 334	3 257	1 468	2 638	2 109	642	1 449	0	0	17 352
Region Total	2 583	3 510	3 429	1 545	2 777	2 221	676	1 526	414	1 103	19 784
Central/East Europe											
Czech Republic	163	39	189	16	60	24	89	96			676
Hungary	107	40	34	10	22	22	24	37			296
Poland	124	133	59	33	56	13	57	46			521
Russia	291	271	327	11	109	133	44	60			1 246
Sub Total	685	483	609	70	247	192	214	239	0	0	2 739
Region Total	806	568	717	82	291	226	252	281	156	309	3 688
Latin America											
Argentina	44	179	36	89	63	9	9	87			516
Brazil	101	496	607	156	201	34	6	161			1 762
Chile	31	75	323	55	58	40	28	0			610
Colombia	10	14	27	11	16	10	2	40			130
Mexico	103	206	403	126	161	98	10	182			1 289
Venezuela	13	19	58	40	44	30	3	42			249
Sub Total	302	989	1 454	477	543	221	58	512	0	0	4 556
Region Total	336	1 098	1 617	530	603	246	65	569	75	203	5 342
TOTAL	3 866	5 574	6 152	2 261	4 045	2 792	1 193	2 446	682	1 689	30 700

Note data only available by region not by individual country

COMPARISON OF ENERGY EFFICIENT MARKET TO GDP

Region/Country	1996 EE Market		1996 GDP		EE Relative to GDP	Aggressive Growth 2015 EE Market		2015 GDP		EE Relative to GDP
	(\$M)	% Total	(\$B)	% Total		(\$M)	% Total	(\$B)	% Total	
Africa/Middle East										
Algeria	53	9%	66	7%	1 18	171	5%	133	6%	0 81
Egypt	34	6%	42	5%	1 21	219	7%	80	4%	1 75
Iran	78	13%	159	18%	0 72	446	14%	332	16%	0 85
Israel	75	12%	78	9%	1 41	332	10%	171	8%	1 24
Kuwait	21	3%	21	2%	1 48	119	4%	43	2%	1 77
Morocco	49	8%	30	3%	2 40	193	6%	69	3%	1 78
Nigeria	15	2%	44	5%	0 51	75	2%	88	4%	0 54
Saudi Arabia	93	15%	120	14%	1 13	544	17%	286	14%	1 21
South Africa	54	9%	109	12%	0 73	245	8%	274	13%	0 57
Turkey	84	14%	174	20%	0 71	663	20%	490	24%	0 86
U A E	45	7%	39	4%	1 69	242	7%	101	5%	1 52
Sub Total	601	100%	880	100%		3 250	100%	2 068	100%	
Region Total	739					3 895				
Asia										
China	1 284	25%	838	34%	0 72	7 545	20%	2 419	34%	0 58
Hong Kong	512	10%	96	4%	2 51	6 602	17%	285	4%	4 32
India	486	9%	388	16%	0 59	2 717	7%	1 021	14%	0 50
Indonesia	463	9%	158	6%	1 38	3 156	8%	468	7%	1 26
Malaysia	167	3%	69	3%	1 13	1 380	4%	200	3%	1 29
Pakistan	61	1%	54	2%	0 53	462	1%	165	2%	0 52
Philippines	127	2%	52	2%	1 15	643	2%	155	2%	0 78
Singapore	354	7%	55	2%	3 01	3 621	10%	160	2%	4 22
South Korea	1 076	21%	385	16%	1 31	6 965	18%	1 125	16%	1 15
Tawan	360	7%	229	9%	0 74	2 990	8%	681	10%	0 82
Thailand	351	7%	136	6%	1 21	1 888	5%	400	6%	0 88
Sub Total	5 239	100%	2 461	100%		37 968	100%	7 077	100%	
Region Total	5 489					39 602				
Central/East Europe										
Czech Republic	256	21%	30	8%	2 78	1 583	14%	62	6%	2 33
Hungary	154	13%	71	18%	0 70	1 784	15%	175	16%	0 93
Poland	282	23%	31	8%	2 91	2 999	26%	51	5%	5 39
Russia	533	44%	264	67%	0 65	5 295	45%	779	73%	0 62
Sub Total	1 225	100%	396	100%		11 661	100%	1 067	100%	
Region Total	1 408					12 988				
Latin America										
Argentina	187	11%	200	17%	0 68	1 153	12%	526	17%	0 74
Brazil	631	38%	588	49%	0 78	3 242	35%	1 486	47%	0 73
Chile	218	13%	43	4%	3 66	1 203	13%	108	3%	3 74
Colombia	48	3%	52	4%	0 66	193	2%	127	4%	0 51
Mexico	472	28%	273	23%	1 25	3 010	32%	764	24%	1 33
Venezuela	117	7%	55	5%	1 53	513	6%	125	4%	1 38
Sub Total	1 672	100%	1 212	100%		9 315	100%	3 138	100%	
Region Total	1 847					10 202				
TOTAL	9 483					66 687				

ECONOMIC GROWTH PAST, PRESENT, AND FUTURE

Region/Country	1993 GDP (\$B 1990)	GDP Growth (1993-5)	GDP Growth (1996-2000)	GDP Growth (1993-6)	GDP Growth (1996-2015)
Africa Regional Total	940				
Africa/Middle East	729	2 2%	4 6%	2 9%	4 4%
Algeria	60	1 8%	5 3%	2 9%	4 3%
Egypt	37	4 3%	4 9%	4 5%	4 2%
Iran	145	1 7%	6 3%	3 2%	4 5%
Israel	66	5 7%	5 7%	5 7%	5 1%
Kuwait	16	10 5%	7 1%	9 3%	5 4%
Morocco	27	4 9%	2 1%	4 0%	5 2%
Nigeria	40	1 7%	5 3%	2 9%	4 3%
Saudi Arabia	114	0 1%	4 7%	1 6%	4 9%
South Africa	101	2 6%	3 3%	2 8%	5 4%
Turkey *	89	5 5%	4 2%	5 1%	5 6%
U A E	35	1 3%	8 6%	3 7%	5 8%
Asia Regional Total	2,027				
Asia	1,949	7 7%	6 9%	7 4%	6 4%
China	623	11 2%	8 9%	10 4%	7 4%
Hong Kong	83	4 9%	5 0%	4 9%	6 7%
India	323	5 9%	7 2%	6 3%	6 2%
Indonesia	128	7 1%	7 2%	7 1%	7 0%
Malaysia	54	8 9%	7 4%	8 4%	7 1%
Pakistan	47	4 3%	6 3%	5 0%	6 9%
Philippines	45	4 7%	5 8%	5 1%	6 7%
Singapore	43	9 1%	6 9%	8 4%	7 1%
South Korea	307	8 5%	6 7%	7 9%	7 1%
Taiwan	189	6 7%	6 3%	6 6%	7 0%
Thailand	107	8 5%	7 8%	8 3%	7 2%
C/EE Regional total	514				
Central/East Europe	469	-5 1%	4 7%	-2 0%	4 9%
Czech Republic *	43	3 1%	4 8%	3 6%	5 7%
Hungary	28	1 5%	3 5%	2 2%	4 3%
Poland	61	5 5%	4 6%	5 2%	5 7%
Romania	29	2 7%	2 5%	2 6%	3 0%
Russia	308	-9 7%	5 0%	-5 0%	5 0%
LAC REgional Total	1,167				
Latin America	1,078	3 5%	4 8%	3 9%	6 0%
Argentina	177	3 8%	4 9%	4 2%	5 9%
Brazil	501	5 8%	4 9%	5 5%	5 9%
Chile	37	5 2%	4 3%	4 9%	5 8%
Colombia	45	5 5%	4 5%	5 1%	5 6%
Mexico	262	-0 4%	5 1%	1 4%	5 8%
Venezuela	56	-2 7%	3 8%	-0 6%	4 3%

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OECD Europe

Sector/Technology Category	1995 (\$ Million)	2015 (\$ Million)	Growth/yr (%)	1996 (\$ Million)
Industrial				
<i>EE Equipment</i>				
High-efficiency boilers	343	398	0.7%	346
Cogeneration equipment	280	358	1.2%	283
Conservation controls	229	373	2.5%	235
High-efficiency motors	286	945	6.2%	304
Adjustable speed drives	286	1,084	6.9%	306
Process controls	1,144	1,866	2.5%	1,172
Waste heat recovery	194	288	2.0%	198
Lighting	200	525	4.9%	210
Insulation	57	70	1.0%	58
Integrated energy/load MS	229	474	3.7%	237
Commercial				
<i>EE Equipment</i>				
High-efficiency HVAC	372	607	2.5%	381
Cogeneration	200	244	1.0%	202
Lighting	1,030	3,562	6.4%	1,096
EMS/Controls	572	1,890	6.2%	607
Building envelope (windows/insulation)	786	2,061	4.9%	825
Residential				
Lighting	443	1,465	6.2%	470
High-efficiency appliances	400	538	1.5%	406
Building envelope	786	1,057	1.5%	798
Total	7,837	17,805	4.2%	8,133

OECD Pacific

Sector/Technology Category	1995 (\$ Million)	2015 (\$ Million)	Growth/yr (%)	1996 (\$ Million)
Industrial				
<i>EE Equipment</i>				
High-efficiency boilers	225	260	0 7%	227
Cogeneration equipment	30	38	1 2%	30
Conservation controls	150	244	2 5%	154
High-efficiency motors	187	618	6 2%	199
Adjustable speed drives	187	709	6 9%	200
Process controls	748	1,221	2 5%	767
Waste heat recovery	127	188	2 0%	130
Lighting	131	343	4 9%	137
Insulation	37	46	1 1%	37
Integrated energy/load MS	150	310	3 7%	156
Commercial				
<i>EE Equipment</i>				
High-efficiency HVAC	243	397	2 5%	249
Cogeneration	75	91	1 0%	76
Lighting	674	2,331	6 4%	717
EMS/Controls	374	1,237	6 2%	397
Building envelope (windows/insulation)	515	1,349	4 9%	540
Residential				
Lighting	290	958	6 2%	308
High-efficiency appliances	262	352	1 5%	266
Building envelope	515	692	1 5%	523
Total	4,920	11,384	4 3%	5,111

US/Canada

Sector/Technology Category	1995 (\$ Million)	2015 (\$ Million)	Growth/yr (%)	1996 (\$ Million)
Industrial				
<i>EE Equipment</i>				
High-efficiency boilers	687	783	0.7%	692
Cogeneration equipment	801	995	1.1%	810
Conservation controls	458	704	2.2%	468
High-efficiency motors	572	1,636	5.4%	603
Adjustable speed drives	572	1,846	6.0%	607
Process controls	2,289	3,520	2.2%	2,339
Waste heat recovery	389	550	1.7%	396
Lighting	401	934	4.3%	418
Insulation	114	136	0.9%	115
Integrated energy/load MS	458	869	3.3%	473
Commercial				
<i>EE Equipment</i>				
High-efficiency HVAC	744	1,144	2.2%	760
Cogeneration	229	272	0.9%	231
Lighting	2,060	6,133	5.6%	2,175
EMS/Controls	1,145	3,273	5.4%	1,207
Building envelope (windows/insulation)	1,574	3,671	4.3%	1,642
Residential				
Lighting	887	2,536	5.4%	935
High-efficiency appliances	801	1,039	1.3%	811
Building envelope	1,574	2,041	1.3%	1,595
Total	15,755	32,082	3.6%	16,276

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Middle East / Africa

Sector/Technology Category	1995 (\$ Million)	2015 (\$ Million)	Growth/yr (%)	1996 (\$ Million)
Industrial				
<i>EE Equipment</i>				
High-efficiency boilers	18	26	1 9%	18
Cogeneration equipment	10	18	3 0%	10
Conservation controls	12	38	5 9%	13
High-efficiency motors	15	239	14 8%	17
Adjustable speed drives	15	325	16 6%	17
Process controls	61	192	5 9%	65
Waste heat recovery	10	26	4 9%	10
Lighting	11	99	11 6%	12
Insulation	3	5	2 6%	3
Integrated energy/load MS	12	67	9 0%	13
Commercial				
<i>EE Equipment</i>				
High-efficiency HVAC	20	62	5 8%	21
Cogeneration	20	32	2 4%	20
Lighting	55	955	15 3%	63
EMS/Controls	30	479	14 9%	34
Building envelope (windows/insulation)	42	391	11 8%	47
Residential				
Lighting	24	371	14 7%	28
High-efficiency appliances	21	43	3 6%	22
Building envelope	42	84	3 5%	43
Total	421	3,452	11 1%	459

Asia / Pacific

Sector/Technology Category	1995 (\$ Million)	2015 (\$ Million)	Growth/yr (%)	1996 (\$ Million)
Industrial				
EE Equipment				
High-efficiency boilers	240	334	1 7%	244
Cogeneration equipment	220	380	2 8%	226
Conservation controls	109	322	5 6%	115
High-efficiency motors	508	6,828	13 9%	578
Adjustable speed drives	120	2,156	15 5%	139
Process controls	546	1,608	5 5%	576
Waste heat recovery	93	221	4 4%	97
Lighting	120	985	11 1%	133
Insulation	27	42	2 2%	28
Integrated energy/load MS	109	540	8 3%	118
Commercial				
EE Equipment				
High-efficiency HVAC	849	2,499	5 5%	896
Cogeneration	145	225	2 2%	148
Lighting	640	9,480	14 4%	732
EMS/Controls	320	4,301	13 9%	364
Building envelope (windows/insulation)	480	3,939	11 1%	533
Residential				
Lighting	320	4,301	13 9%	364
High-efficiency appliances	784	1,509	3 3%	810
Building envelope	480	924	3 3%	496
Total	6,110	40,594	9 9%	6,599

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Eastern Europe

Sector/Technology Category	1995 (\$ Million)	2015 (\$ Million)	Growth/yr (%)	1996 (\$ Million)
Industrial				
<i>EE Equipment</i>				
High-efficiency boilers	72	106	2 0%	73
Cogeneration equipment	45	86	3 3%	46
Conservation controls	48	169	6 5%	51
High-efficiency motors	60	1,227	16 3%	70
Adjustable speed drives	60	1,714	18 2%	71
Process controls	239	846	6 5%	255
Waste heat recovery	41	112	5 2%	43
Lighting	42	486	13 0%	47
Insulation	12	20	2 6%	12
Integrated energy/load MS	48	309	9 8%	53
Commercial				
<i>EE Equipment</i>				
High-efficiency HVAC	78	275	6 5%	83
Cogeneration	75	126	2 6%	77
Lighting	215	4,941	17 0%	251
EMS/Controls	119	2,455	16 3%	138
Building envelope (windows/insulation)	164	1,911	13 1%	185
Residential				
Lighting	93	1,902	16 3%	108
High-efficiency appliances	84	180	3 9%	87
Building envelope	164	354	3 9%	170
Total	1,659	17,219	12 4%	1,823

Latin America

Sector/Technology Category	1995 (\$ Million)	2015 (\$ Million)	Growth/yr (%)	1996 (\$ Million)
Industrial				
<i>EE Equipment</i>				
High-efficiency boilers	51	70	1 6%	52
Cogeneration equipment	75	130	2 8%	77
Conservation controls	23	68	5 6%	24
High-efficiency motors	107	1,441	13 9%	122
Adjustable speed drives	25	455	15 6%	29
Process controls	116	342	5 6%	122
Waste heat recovery	20	47	4 4%	21
Lighting	25	208	11 2%	28
Insulation	6	9	2 0%	6
Integrated energy/load MS	23	115	8 4%	25
Commercial				
<i>EE Equipment</i>				
High-efficiency HVAC	179	528	5 6%	189
Cogeneration	40	62	2 2%	41
Lighting	135	2,000	14 4%	154
EMS/Controls	68	908	13 8%	77
Building envelope (windows/insulation)	101	831	11 1%	112
Residential				
Lighting	68	908	13 8%	77
High-efficiency appliances	165	319	3 4%	171
Building envelope	101	195	3 3%	104
Total	1,328	8,636	9 8%	1,432

ENERGY EFFICIENT BUILDING CONTROLS MARKET

Region/Country	1995 (\$ million)	Average Annual Growth (1993 6)	Est 1996 Total Import Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)	
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)
Africa/Middle East	30	3 4%				31	4 7%	74
Algeria						6		
Egypt						1		
Iran						6		
Israel						1		
Kuwait						0		
Morocco						1		
Nigeria						1		
Saudi Arabia						5		
South Africa						2		
Turkey						6		
U A E						2		
Sub Total	0		0			31		0
% of Region Total	80%					31		74
Asia	320	8 0%				346	6 3%	1 103
China						67		
Hong Kong						30		
India						48		
Indonesia						41		
Malaysia						11		
Pakistan						7		
Philippines						6		
Singapore						9		
South Korea						87		
Taiwan						24		
Thailand						16		
Sub Total	0		0			346		0
% of Region Total	95%					346		1 103
Central/East Europe	119	4 7%				125	4 9%	309
Czech Republic						9		
Hungary						12		
Poland						40		
Russia						63		
Sub Total	0		0			125		0
% of Region Total	85%					125		309
Latin America	68	4 0%				71	5 7%	203
Argentina						13		
Brazil						35		
Chile						5		
Colombia						1		
Mexico						15		
Venezuela						2		
Sub Total	0		0			71		0
% of Region Total	90%					71		203

US - 100%

TOTAL						572		1 690
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Note No individual country data obtained Regional estimates only

Aggressive Growth (Hagler Bailly Forecast)		
Average Annual Growth		Est 2015 Total Efficient (\$ million)
(1996 2000)	(2001 2015)	
15%	15%	447
		51
		30
		52
		22
		9
		20
		5
		90
		20
		135
		15
		447
15%	15%	4 919
		790
		304
		744
		644
		170
		67
		94
		136
		1 356
		365
		248
		4 919
		4,919
15%	17 5%	2 448
		176
		210
		843
		1 220
		2 448
		2 448
12 5%	15 0%	922
		158
		481
		74
		9
		185
		16
		922
		922

US

8 736

50

ENERGY EFFICIENT HVAC MARKET

**Conservative Growth
(TRACK GDP)**

**Aggressive Growth
(Hagler Baily Forecast)**

Region/Country	Imports 1993 SITCs 741 (\$ million)	Average Annual Growth (1993 6)	Est 1996 Total Import Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)	
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)
Africa/Middle East								
Algeria	182	2 9%	198	2 5%	90 0%	6	4 3%	12
Egypt	118	4 5%	135	5 0%	90 0%	7	4 2%	16
Iran	500	3 2%	550	2 5%	90 0%	15	4 5%	35
Israel	110	5 7%	130	5 0%	90 0%	7	5 1%	19
Kuwait	100	9 3%	131	5 0%	90 0%	7	5 4%	20
Morocco	86	4 0%	97	5 0%	90 0%	5	5 2%	14
Nigeria	93	2 9%	101	2 5%	90 0%	3	4 3%	6
Saudi Arabia	387	1 6%	406	5 0%	90 0%	23	4 9%	56
South Africa	266	2 8%	289	5 0%	90 0%	16	5 4%	44
Turkey	228	1 1%	236	5 0%	90 0%	13	5 8%	38
U A E	214	3 7%	239	5 0%	90 0%	13	5 8%	39
Sub Total	2 284		2 510			116		299
% of Region Total	80%					145		374
Asia								
China	784	10 4%	1 055	3 5%	15 0%	246	7 4%	956
Hong Kong	968	4 9%	1 117	3 5%	95 0%	41	6 7%	141
India	210	6 3%	252	3 5%	90 0%	10	6 2%	31
Indonesia	547	7 1%	672	3 5%	90 0%	26	7 0%	95
Malaysia	406	8 4%	517	3 5%	95 0%	19	7 1%	70
Pakistan	140	5 0%	162	3 5%	90 0%	6	6 9%	22
Philippines	87	5 1%	101	3 5%	50 0%	7	6 7%	24
Singapore	601	8 4%	766	3 5%	67 0%	40	7 1%	147
South Korea	966	7 9%	1 214	3 5%	20 0%	212	7 1%	782
Taiwan	562	6 6%	681	3 5%	70 0%	34	7 0%	123
Thailand	542	8 3%	688	3 5%	37 0%	66	7 2%	247
Sub Total	5 813		7 225			708		2 638
% of Region Total	95%					745		2 777
Central/East Europe								
Czech Republic	226	3 6%	251	5 0%	60 0%	21	5 7%	60
Hungary	112	2 2%	120	5 0%	60 0%	10	4 3%	22
Poland	173	5 2%	201	5 0%	40 0%	25	4 3%	56
Russia	532	5 0%	456	5 0%	60 0%	38	5 7%	109
Sub Total	1 043		1 028			94		247
% of Region Total	85%					111		291
Latin America								
Argentina	188	4 2%	213	5 0%	50 0%	21	5 9%	63
Brazil	115	5 5%	135	5 0%	10 0%	68	5 9%	201
Chile	138	4 9%	159	5 0%	40 0%	20	5 8%	58
Colombia	48	5 1%	56	5 0%	50 0%	6	5 6%	16
Mexico	424	1 4%	442	5 0%	40 0%	55	5 8%	161
Venezuela	200	0 6%	196	5 0%	50 0%	20	4 3%	44
Sub Total	1 113		1 201			189		543
% of Region Total	90%					210		603

Average Annual Growth		Est 2015 Total Efficient (\$ million)
(1996 2000)	(2001 2015)	
5 0%	5 0%	14
15 0%	5 0%	27
5 0%	5 0%	39
10 0%	5 0%	22
5 0%	5 0%	18
10 0%	5 0%	16
5 0%	5 0%	7
10 0%	5 0%	69
5 0%	5 0%	41
10 0%	5 0%	40
15 0%	5 0%	48
		341
		426
15 0%	7 5%	1 274
10 0%	5 0%	125
10 0%	5 0%	30
15 0%	7 5%	135
7 5%	7 5%	75
7 0%	7 0%	23
10 0%	7 0%	29
10 0%	7 5%	173
7 0%	7 0%	768
10 0%	7 0%	138
10 0%	7 5%	285
		3 055
		3 216
10 0%	5 0%	64
10 0%	5 0%	30
10 0%	5 0%	77
10 0%	5 0%	116
		286
		337
10 0%	5 0%	65
5 0%	5 0%	171
10 0%	5 0%	61
5 0%	5 0%	14
10 0%	7 5%	239
5 0%	5 0%	50
		599
		666

US - ~5%

US

TOTAL						1 211		4 044
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4 644

51

ENERGY EFFICIENT BUILDING ENVELOPE MARKET (Insulation and EE Windows)

Region/Country	1996 EIU Construction Mkt (\$ million)	Average Annual Growth (1993 6)	Est 1996 Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)		Aggressive Growth (Hagler Bailly Forecast)		
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)	Average Annual Growth		Est 2015 Total Efficient (\$ million)
									(1996 2000) (see note)	(2001 2015) (see note)	
Africa/Middle East											
Algeria	4 776	NA	4 776	0 5%	NA	24	4 3%	53	5 0%	5 0%	60
Egypt	1 170	NA	1 170	0 5%	NA	6	4 2%	13	10 0%	5 0%	18
Iran	4 535	NA	4 535	0 5%	NA	23	4 5%	52	7 0%	5 0%	62
Israel	816	NA	816	0 5%	NA	4	5 1%	10	11 0%	10 0%	26
Kuwait	317	NA	317	0 5%	NA	2	5 4%	4	12 0%	10 0%	10
Morocco	811	NA	811	0 5%	NA	4	5 2%	11	9 0%	10 0%	24
Nigeria	479	NA	479	0 5%	NA	2	4 3%	5	5 0%	5 0%	6
Saudi Arabia	3 899	NA	3 899	0 5%	NA	19	4 9%	48	7 0%	7 0%	71
South Africa	1 926	NA	1 926	0 5%	NA	10	5 4%	26	5 0%	5 0%	24
Turkey	5 255	NA	5 255	0 5%	NA	26	5 8%	77	10 0%	7 0%	106
U A E	1 258	NA	1 258	0 5%	NA	6	5 8%	18	7 5%	5 0%	17
Sub Total	25 242		25 242			126		319			425
% of Region Total	80%					158		398			531
Asia											
China	35 732	NA	35 732	0 5%	NA	179	7 4%	694	10 0%	7 0%	722
Hong Kong	4 052	NA	4 052	2 0%	NA	81	6 7%	278	7 0%	7 0%	293
India	12 805	NA	12 805	1 0%	NA	128	6 2%	402	10 0%	6 0%	449
Indonesia	5 545	NA	5 545	2 0%	NA	111	7 0%	401	10 0%	7 0%	448
Malaysia	2 933	NA	2 933	1 0%	NA	29	7 1%	108	10 0%	7 0%	118
Pakistan	1 787	NA	1 787	1 0%	NA	18	6 9%	63	7 0%	7 0%	65
Philippines	1 611	NA	1 611	1 0%	NA	16	6 7%	55	10 0%	7 0%	65
Singapore	2 340	NA	2 340	1 0%	NA	23	7 1%	86	10 0%	7 0%	95
South Korea	23 349	NA	23 349	1 0%	NA	233	7 1%	860	10 0%	7 0%	943
Taiwan	6 290	NA	6 290	1 0%	NA	63	7 0%	227	10 0%	7 0%	254
Thailand	4 273	NA	4 273	1 0%	NA	43	7 2%	160	10 0%	7 0%	173
Sub Total	100 717		100 717			924		3 334			3 625
% of Region Total	95%					973		3 510			3 815
Central/East Europe											
Czech Republic	681	NA	681	2 0%	NA	14	5 7%	39	7 5%	12 0%	100
Hungary	894	NA	894	2 0%	NA	18	4 3%	40	5 0%	10 0%	91
Poland	2 978	NA	2 978	2 0%	NA	60	4 3%	133	10 0%	10 0%	364
Russia	9 455	NA	9 455	1 0%	NA	95	5 7%	271	7 5%	12 0%	691
Sub Total	14 008		14 008			186		482			1 246
% of Region Total	85%					218		568			1 466
Latin America											
Argentina	6 016	NA	6 016	1 0%	NA	60	5 9%	179	5 0%	10 0%	305
Brazil	16 705	NA	16 705	1 0%	NA	167	5 9%	496	7 5%	10 0%	932
Chile	1 280	NA	1 280	2 0%	NA	26	5 8%	75	7 5%	10 0%	143
Colombia	972	NA	972	0 5%	NA	5	5 6%	14	5 0%	7 5%	17
Mexico	7 055	NA	7 055	1 0%	NA	71	5 8%	206	5 0%	10 0%	358
Venezuela	1 713	NA	1 713	0 5%	NA	9	4 3%	19	5 0%	7 5%	31
Sub Total	33 741		33 741			337		989			1 787
% of Region Total	90%					374		1 098			1 985
US 0 3% EE ins 1 8% all ins 0 5% ee windows											
TOTAL								5 574			7 797

Italics denotes estimates derived based on GDP ratios

Three sizes 2% high 1% avg 0 5% low

Growth based on recent construction growth+2 5% for EE
Long term HB estimate

MS

COGENERATION MARKET (equipment only)

Region/Country	HB Estimates				Total PURPA (MW)	Total Self Gen (MW)	Total Both (MW)	Est 1996 Mkt Avg 95-00 PURPA type (M\$ see note)	Est 1996 Mkt Avg of 10-yr Total (M\$ see note)	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)		Aggressive Growth (Hagler Bailly Forecast)				
	1995 2000 PURPA type (MW)	2001 2004 PURPA type (MW)	1995 2000 Self Gen (MW)	2001 2004 Self Gen (MW)							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)	Average Annual Growth (1996 2005) (2006 2015) (see note) (see note)		Est 2015 Total Efficient (\$ million)		
Africa/Middle East																	
Algeria					0	0	0	0	0	0	4 3 /	0	0 0 /	0 0 %	0	0	
Egypt					0	0	0	0	0	0	4 2 %	0	0 0 %	0 0 %	0	0	
Iran					0	0	0	0	0	0	4 5 %	0	0 0 %	0 0 %	0	0	
Israel	205	325	75	100	530	175	705	17	35	17	5 1 /	44	8 0 %	4 0 %	51	0	
Kuwait					0	0	0	0	0	0	5 4 %	0	0 0 %	0 0 %	0	0	
Morocco					0	0	0	0	0	0	5 2 /	0	0 0 %	0 0 %	0	0	
Nigeria					0	0	0	0	0	0	4 3 %	0	0 0 %	0 0 %	0	0	
Saudi Arabia					0	0	0	0	0	0	4 9 %	0	0 0 %	0 0 %	0	0	
South Africa					0	0	0	0	0	0	5 4 %	0	0 0 %	0 0 %	0	0	
Turkey	50	160	250	300	210	550	760	4	38	4	5 8 /	12	20 0 %	10 0 %	56	0	
U A E					0	0	0	0	0	0	5 8 /	0	0 0 %	0 0 %	0	0	
Sub Total	255	485	325	400	740	725	1 465	21	73	21		56				106	
% of Region Total	80%									27		70					133
Asia																	
China	1 275	975	700	1 250	2 250	1 950	4 200	106	210	106	7 4 %	412	8 0 /	4 0 %	314	0	
Hong Kong					0	0	0	0	0	0	6 7 %	0	0 0 /	0 0 %	0	0	
India	350	260	805	450	610	1 255	1 865	29	93	29	6 2 /	91	10 0 /	5 0 %	112	0	
Indonesia	470	300	400	350	770	750	1 520	39	76	39	7 0 /	142	8 0 /	4 0 %	116	0	
Malaysia	0	250	200	350	250	550	800	0	40	0	7 1 /	0	0 0 %	0 0 %	0	0	
Pakistan	0	0	370	0	0	370	370	0	19	0	6 9 /	0	0 0 /	0 0 %	0	0	
Philippines	708	285	200	190	993	390	1 383	59	69	59	6 7 /	202	2 0 %	1 0 %	78	0	
Singapore					0	0	0	0	0	0	7 1 /	0	0 0 /	0 0 %	0	0	
South Korea	493	250	200	250	743	450	1 193	41	60	41	7 1 %	151	4 0 /	2 0 %	71	0	
Taiwan	500	525	0	0	1 025	0	1 025	42	51	42	7 0 %	151	2 0 /	1 0 %	55	0	
Thailand	960	840	481	360	1 800	841	2 641	80	132	80	7 2 /	300	6 0 %	3 0 %	182	0	
Sub Total	4 756	3 685	3 356	3 200	8 441	6 556	14 997	396	750	396		1 450				928	
% of Region Total	95 /									417		1 526					977
Central/East Europe																	
Czech Republic	400	150	200	200	550	400	950	33	48	33	5 7 /	96	4 0 /	2 0 %	58	0	
Hungary	200	150	0	0	350	0	350	17	18	17	4 3 /	37	1 0 /	0 5 %	19	0	
Poland	250	325	0	100	575	100	675	21	34	21	4 3 /	46	5 0 /	2 5 %	41	0	
Russia	250	500	250	325	750	575	1 325	21	66	21	5 7 /	60	10 0 /	5 0 %	80	0	
Sub Total	1 100	1 125	450	625	2 225	1 075	3 300	92	165	92		239				198	
/ of Region Total	85%									108		281					234
Latin America																	
Argentina	350	325	400	395	675	795	1 470	29	74	29	5 9 /	87	10 0 /	5 0 %	112	0	
Brazil	652	250	880	800	902	1 680	2 582	54	129	54	5 9 /	161	10 0 /	5 0 %	209	0	
Chile	0	100	200	100	300	300	400	0	20	0	5 8 %	0	0 0 /	0 0 %	0	0	
Colombia	170	0	180	230	170	410	580	14	29	14	5 6 /	40	8 0 %	4 0 %	42	0	
Mexico	749	515	125	255	1 264	380	1 644	62	82	62	5 8 /	182	3 0 /	1 5 %	95	0	
Venezuela	225	400	300	0	625	300	925	19	46	19	4 3 /	42	10 0 /	5 0 %	72	0	
Sub Total	2 146	1 590	2 085	1 780	3 736	3 865	7 601	179	380	179		512				529	
% of Region Total	90 %									199		569					588

US 100%

TOTAL	750	2 446
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US

1 931

Market value based on \$1 000/kW and 50 % equipment

Growth rate for first window based on growth of total (self+PURPA) vs first period PURPA second window at 1/2 of first

53

ENERGY EFFICIENT APPLIANCE MARKET

Region/Country	Imports 1993 SITCs 775 (\$ million)	Average Annual Growth (1993 6)	Est 1996 Total Import Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)	
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)
Africa/Middle East								
Algeria	109	2 9%	119	2 0%	90 0%	3	4 3%	6
Egypt	32	4 5%	37	2 0%	90 0%	1	4 2%	2
Iran	106	3 2%	117	2 0%	90 0%	3	4 5%	6
Israel	153	5 7%	181	2 0%	90 0%	4	5 1%	10
Kuwait	80	9 3%	104	2 0%	90 0%	2	5 4%	6
Morocco	49	4 0%	55	2 0%	90 0%	1	5 2%	3
Nigeria	73	2 9%	80	2 0%	90 0%	2	4 3%	4
Saudi Arabia	297	1 6%	311	2 0%	90 0%	7	4 9%	17
South Africa	132	2 8%	143	2 0%	90 0%	3	5 4%	9
Turkey	91	1 1%	94	2 0%	90 0%	2	5 8%	6
U A E	188	3 7%	210	2 0%	90 0%	5	5 8%	14
Sub Total	1 310		1 450			32		83
% of Region Total	80%					40		104
Asia								
China	158	10 4%	213	3 0%	4 3%	148	7 4%	576
Hong Kong	1 398	4 9%	1 614	4 0%	95 0%	68	6 7%	233
India	539	6 3%	647	4 0%	90 0%	29	6 2%	90
Indonesia	32	7 1%	39	4 0%	7 2%	22	7 0%	79
Malaysia	84	8 4%	107	4 0%	95 0%	5	7 1%	17
Pakistan	78	5 0%	90	3 0%	90 0%	3	6 9%	11
Philippines	75	5 1%	87	4 0%	90 0%	4	6 7%	13
Singapore	246	8 4%	313	3 0%	95 0%	10	7 1%	36
South Korea	113	7 9%	142	4 0%	12 5%	45	7 1%	167
Taiwan	315	6 6%	382	4 0%	70 0%	22	7 0%	79
Thailand	105	8 3%	133	10 0%	30 0%	44	7 2%	167
Sub Total	3 143		3 768			400		1 468
% of Region Total	95%					421		1 545
Central/East Europe								
Czech Republic	99	3 6%	110	3 0%	60 0%	6	5 7%	16
Hungary	85	2 2%	91	3 0%	60 0%	5	4 3%	10
Poland	106	5 2%	123	3 0%	25 0%	15	4 3%	33
Russia	114	5 0%	98	3 0%	80 0%	4	5 7%	11
Sub Total	404		422			29		69
% of Region Total	85%					34		82
Latin America								
Argentina	133	4 2%	150	4 0%	20 0%	30	5 9%	89
Brazil	48	5 5%	56	4 0%	4 3%	52	5 9%	156
Chile	65	4 9%	75	5 0%	20 0%	19	5 8%	55
Colombia	28	5 1%	33	3 0%	25 0%	4	5 6%	11
Mexico	289	1 4%	301	5 0%	34 9%	43	5 8%	126
Venezuela	49	0 6%	48	5 0%	13 5%	18	4 3%	40
Sub Total	612		664			166		477
% of Region Total	90%					185		530

Aggressive Growth (Hagler Bailly Forecast)		
Average Annual Growth		Est 2015 Total Efficient (\$ million)
(1996 2000)	(2001 2015)	
4 0%	4 0%	6
10 0%	4 0%	2
5 0%	5 0%	7
5 0%	5 0%	10
5 0%	5 0%	6
10 0%	5 0%	4
4 0%	4 0%	4
10 0%	5 0%	21
5 0%	5 0%	8
10 0%	6 0%	7
6 0%	6 0%	14
		88
		110
10 0%	7 0%	599
10 0%	7 0%	274
10 0%	6 0%	101
7 0%	7 0%	79
7 0%	7 0%	16
7 0%	7 0%	11
7 0%	7 0%	14
10 0%	7 0%	40
10 0%	7 0%	183
10 0%	7 0%	88
10 0%	7 0%	180
		1 586
		1 669
10 0%	5 0%	17
10 0%	5 0%	14
10 0%	5 0%	45
7 0%	5 0%	10
		86
		101
7 5%	5 0%	84
10 0%	5 0%	160
10 0%	5 0%	57
5 0%	5 0%	10
10 0%	5 0%	131
10 0%	5 0%	54
		496
		551

US - 4%

TOTAL							679	2 260
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US -

2 431

SK

ENERGY EFFICIENT BOILER MARKET

Region/Country	Imports 1993 SITCs 7111 (\$ million)	Average Annual Growth (1993 6)	Est 1996 Total Import Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)	
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)
Africa/Middle East								
Algeria	58	2 9%	63	10 0%	90 0%	7	4 3%	16
Egypt	3	4 5%	3	20 0%	70 0%	1	4 2%	2
Iran	16	3 2%	18	10 0%	90 0%	2	4 5%	5
Israel	25	5 7%	30	20 0%	70 0%	8	5 1%	22
Kuwait	8	9 3%	10	10 0%	90 0%	1	5 4%	3
Morocco	76	4 0%	85	20 0%	60 0%	28	5 2%	75
Nigeria	4	2 9%	4	10 0%	90 0%	0	4 3%	1
Saudi Arabia	12	1 6%	13	20 0%	60 0%	4	4 9%	10
South Africa	24	2 8%	26	10 0%	90 0%	3	5 4%	8
Turkey	10	1 1%	10	20 0%	50 0%	4	5 8%	12
U A E	16	3 7%	18	10 0%	80 0%	2	5 8%	7
Sub Total	252		281			62		160
% of Region Total	80%					77		200
Asia								
China	91	10 4%	122	20 0%	25 0%	98	7 4%	380
Hong Kong	17	4 9%	20	20 0%	90 0%	4	6 7%	15
India	6	6 3%	7	25 0%	90 0%	2	6 2%	6
Indonesia	57	7 1%	70	25 0%	90 0%	19	7 0%	70
Malaysia	11	8 4%	14	25 0%	90 0%	4	7 1%	14
Pakistan	5	5 0%	6	20 0%	90 0%	1	6 9%	5
Philippines	5	5 1%	6	25 0%	90 0%	2	6 7%	6
Singapore	17	8 4%	22	25 0%	90 0%	6	7 1%	22
South Korea	41	7 9%	52	25 0%	90 0%	14	7 1%	53
Taiwan	29	6 6%	35	25 0%	90 0%	10	7 0%	35
Thailand	27	8 3%	34	25 0%	90 0%	10	7 2%	36
Sub Total	306		387			170		642
% of Region Total	95%					179		676
Central/East Europe								
Czech Republic	14	3 6%	16	20 0%	10 0%	31	5 7%	89
Hungary	5	2 2%	5	20 0%	10 0%	11	4 3%	24
Poland	11	5 2%	13	20 0%	10 0%	26	4 3%	57
Russia	9	5 0%	8	20 0%	10 0%	15	5 7%	44
Sub Total	39		41			83		214
% of Region Total	85%					97		252
Latin America								
Argentina	12	4 2%	14	20 0%	90 0%	3	5 9%	9
Brazil	4	5 5%	5	20 0%	50 0%	2	5 9%	6
Chile	28	4 9%	32	25 0%	85 0%	10	5 8%	28
Colombia	3	5 1%	3	20 0%	90 0%	1	5 6%	2
Mexico	8	1 4%	8	25 0%	60 0%	3	5 8%	10
Venezuela	4	0 6%	4	20 0%	50 0%	2	4 3%	3
Sub Total	59		66			20		58
% of Region Total	90%					22		65

Aggressive Growth (Hagler Bailly Forecast)		
Average Annual Growth		Est 2015 Total Efficient (\$ million)
(1996 2000)	(2001 2015)	
5 0%	5 0%	18
25 0%	8 0%	8
20 0%	8 0%	13
10 0%	5 0%	26
20 0%	10 0%	10
5 0%	5 0%	72
5 0%	5 0%	1
10 0%	5 0%	13
5 0%	5 0%	7
10 0%	10 0%	25
20 0%	8 0%	15
		207
		259
10 0%	5 0%	298
5 0%	5 0%	11
10 0%	7 0%	8
10 0%	7 0%	79
10 0%	7 0%	16
20 0%	7 0%	7
10 0%	7 0%	7
20 0%	7 0%	34
15 0%	7 0%	69
20 0%	7 0%	56
20 0%	7 0%	55
		639
		673
10 0%	6 0%	109
10 0%	5 0%	32
10 0%	5 0%	78
5 0%	6 0%	45
		265
		311
20 0%	7 0%	17
10 0%	7 0%	8
10 0%	7 0%	38
5 0%	7 0%	3
25 0%	7 0%	23
15 0%	7 0%	8
		97
		108

US ~30%

TOTAL	377	1 192
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US -

1 351

SS

PROCESS CONTROLS MARKET

Region/Country	Imports 1993 SITCs 874 - 874 2 (\$ million)	Average Annual Growth (1993 6)	Est 1996 Total Import Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)	
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)
Africa/Middle East								
Algeria	83	2 9%	90	5 0%	100 0%	5	4 3%	10
Egypt	72	4 5%	82	10 0%	100 0%	8	4 2%	18
Iran	273	3 2%	300	5 0%	100 0%	15	4 5%	35
Israel	171	5 7%	202	10 0%	90 0%	22	5 1%	58
Kuwait	31	9 3%	40	10 0%	100 0%	4	5 4%	11
Morocco	53	4 0%	60	10 0%	100 0%	6	5 2%	16
Nigeria	69	2 9%	75	5 0%	100 0%	4	4 3%	8
Saudi Arabia	174	1 6%	182	10 0%	100 0%	18	4 9%	45
South Africa	228	2 8%	248	5 0%	100 0%	12	5 4%	34
Turkey	185	1 1%	191	10 0%	100 0%	19	5 8%	56
U A E	131	3 7%	146	5 0%	100 0%	7	5 8%	21
Sub Total	1 470		1 617			121		311
% of Region Total	80%					151		389
Asia								
China	794	10 4%	1 068	10 0%	50 0%	214	7 4%	830
Hong Kong	360	4 9%	416	10 0%	90 0%	46	6 7%	158
India	281	6 3%	338	15 0%	50 0%	101	6 2%	318
Indonesia	257	7 1%	316	35 0%	90 0%	123	7 0%	444
Malaysia	340	8 4%	433	10 0%	90 0%	48	7 1%	177
Pakistan	66	5 0%	76	10 0%	90 0%	8	6 9%	30
Philippines	108	5 1%	125	10 0%	90 0%	14	6 7%	48
Singapore	640	8 4%	815	10 0%	90 0%	91	7 1%	333
South Korea	1 179	7 9%	1 481	10 0%	90 0%	165	7 1%	606
Taiwan	455	6 6%	551	10 0%	90 0%	61	7 0%	221
Thailand	174	8 3%	221	10 0%	90 0%	25	7 2%	92
Sub Total	4 654		5 841			895		3 257
% of Region Total	95%					942		3 429
Central/East Europe								
Czech Republic	198	3 6%	220	15 0%	50 0%	66	5 7%	189
Hungary	87	2 2%	93	15 0%	90 0%	15	4 3%	34
Poland	136	5 2%	158	15 0%	90 0%	26	4 3%	59
Russia	133	5 0%	114	30 0%	30 0%	114	5 7%	327
Sub Total	554		585			222		609
% of Region Total	85%					261		717
Latin America								
Argentina	96	4 2%	109	10 0%	90 0%	12	5 9%	36
Brazil	290	5 5%	341	15 0%	25 0%	204	5 9%	607
Chile	72	4 9%	83	20 0%	15 0%	111	5 8%	323
Colombia	74	5 1%	86	10 0%	90 0%	10	5 6%	27
Mexico	477	1 4%	497	25 0%	90 0%	138	5 8%	403
Venezuela	120	0 6%	118	20 0%	90 0%	26	4 3%	58
Sub Total	1 129		1 233			501		1 455
% of Region Total	90%					557		1 617

Aggressive Growth (Hagler Bailly Forecast)		
Average Annual Growth		Est 2015 Total Efficient (\$ million)
(1996 2000)	(2001 2015)	
4 0%	4 0%	10
10 0%	5 0%	25
10 0%	5 0%	46
10 0%	5 0%	68
10 0%	5 0%	12
10 0%	5 0%	18
10 0%	10 0%	23
10 0%	5 0%	56
10 0%	10 0%	76
10 0%	10 0%	117
10 0%	5 0%	22
		472
		590
7 0%	7 0%	773
15 0%	5 0%	168
15 0%	5 0%	368
15 0%	5 0%	446
15 0%	5 0%	175
7 0%	7 0%	31
10 0%	5 0%	42
15 0%	5 0%	329
10 0%	5 0%	501
15 0%	5 0%	223
10 0%	5 0%	75
		3 131
		3 296
10 0%	5 0%	201
10 0%	5 0%	47
15 0%	5 0%	96
10 0%	5 0%	347
		691
		813
15 0%	5 0%	44
10 0%	5 0%	622
15 0%	5 0%	403
10 0%	5 0%	29
10 0%	5 0%	420
10 0%	5 0%	80
		1 598
		1 775

US - -8%

TOTAL	1 912	6 152
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US -

6 475

ENERGY EFFICIENT MOTOR MARKET

**Conservative Growth
(TRACK GDP)**

**Aggressive Growth
(Hagler Bailly Forecast)**

Region/Country	Imports 1993 SITCs 71621 (\$ million)	Average Annual Growth (1993 6)	Est 1996 Total Import Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)	
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)
Africa/Middle East								
Algeria	14	2 9%	15	10 0%	95 0%	2	4 3%	4
Egypt	28	4 5%	32	10 0%	95 0%	3	4 2%	7
Iran	63	3 2%	69	10 0%	95 0%	7	4 5%	17
Israel	27	5 7%	32	10 0%	95 0%	3	5 1%	9
Kuwait	6	9 3%	8	10 0%	95 0%	1	5 4%	2
Morocco	9	4 0%	10	10 0%	95 0%	1	5 2%	3
Nigeria	9	2 9%	10	10 0%	95 0%	1	4 3%	2
Saudi Arabia	39	1 6%	41	10 0%	95 0%	4	4 9%	11
South Africa	25	2 8%	27	10 0%	95 0%	3	5 4%	8
Turkey	34	1 1%	35	10 0%	95 0%	4	5 8%	11
U A E	14	3 7%	16	10 0%	70 0%	2	5 8%	7
Sub Total	268		295			32		79
% of Region Total	80%					40		99
Asia								
China	84	10 4%	113	10 0%	10 0%	113	7 4%	439
Hong Kong	220	4 9%	254	10 0%	90 0%	28	6 7%	97
India	17	6 3%	20	10 0%	30 0%	7	6 2%	21
Indonesia	45	7 1%	55	10 0%	10 0%	55	7 0%	200
Malaysia	127	8 4%	162	10 0%	90 0%	18	7 1%	66
Pakistan	37	5 0%	43	10 0%	90 0%	5	6 9%	17
Philippines	14	5 1%	16	10 0%	20 0%	8	6 7%	28
Singapore	513	8 4%	653	10 0%	90 0%	73	7 1%	267
South Korea	159	7 9%	200	10 0%	10 0%	200	7 1%	735
Taiwan	154	6 6%	187	10 0%	60 0%	31	7 0%	112
Thailand	107	8 3%	136	10 0%	40 0%	34	7 2%	127
Sub Total	1 477		1 839			572		2 110
% of Region Total	95%					602		2 221
Central/East Europe								
Czech Republic	19	3 6%	21	10 0%	25 0%	8	5 7%	24
Hungary	23	2 2%	25	10 0%	25 0%	10	4 3%	22
Poland	13	5 2%	15	10 0%	25 0%	6	4 3%	13
Russia	135	5 0%	116	10 0%	25 0%	46	5 7%	133
Sub Total	190		177			71		192
% of Region Total	85%					83		226
Latin America								
Argentina	18	4 2%	20	10 0%	66 0%	3	5 9%	9
Brazil	49	5 5%	58	10 0%	50 0%	12	5 9%	34
Chile	27	4 9%	31	40 0%	90 0%	14	5 8%	40
Colombia	13	5 1%	15	15 0%	66 0%	3	5 6%	10
Mexico	85	1 4%	89	25 0%	66 0%	34	5 8%	98
Venezuela	36	0 6%	35	25 0%	66 0%	13	4 3%	30
Sub Total	228		248			79		221
% of Region Total	90%					88		246

Average Annual Growth		Est 2015 Total Efficient (\$ million)
(1996 2000)	(2001 2015)	
5 0%	5 0%	4
20 0%	15 0%	57
20 0%	15 0%	123
15 0%	15 0%	48
20 0%	15 0%	14
20 0%	15 0%	18
10 0%	10 0%	6
20 0%	15 0%	73
10 0%	10 0%	17
25 0%	15 0%	73
10 0%	10 0%	14
		447
		559
10 0%	10 0%	691
20 0%	15 0%	476
10 0%	15 0%	81
15 0%	15 0%	787
20 0%	15 0%	303
5 0%	10 0%	24
10 0%	15 0%	97
15 0%	15 0%	1 033
10 0%	15 0%	2 380
10 0%	15 0%	370
10 0%	15 0%	405
		6 648
		6 997
5 0%	10 0%	43
10 0%	15 0%	117
15 0%	15 0%	86
10 0%	15 0%	552
		798
		938
20 0%	15 0%	52
10 0%	10 0%	70
15 0%	15 0%	197
10 0%	10 0%	21
20 0%	15 0%	566
5 0%	10 0%	68
		975
		1 083

US - -30% over 1 hp, -10% all

US -

TOTAL	812	2 793
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ENERGY EFFICIENT ADJUSTABLE SPEED DRIVES MARKET

Region/Country	1995 (\$ million)	Average Annual Growth (1993 6)	Est 1996 Total Import Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Grow 1 (TRACK GDP)	
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)
Africa/Middle East	15	3 4%				16	4 7%	37
Algeria						0		
Egypt						1		
Iran						5		
Israel						1		
Kuwait						0		
Morocco						0		
Nigeria						0		
Saudi Arabia						2		
South Africa						1		
Turkey						2		
U A E						1		
Sub Total	0		0			16		0
% of Region Total	80%					16		37
Asia	120	8 0%				130	6 3%	414
China						36		
Hong Kong						10		
India						2		
Indonesia						11		
Malaysia						4		
Pakistan						1		
Philippines						2		
Singapore						20		
South Korea						33		
Taiwan						7		
Thailand						5		
Sub Total	0		0			130		0
% of Region Total	95%					130		414
Central/East Europe	60	4 7%				63	4 9%	156
Czech Republic						11		
Hungary						9		
Poland						7		
Russia						35		
Sub Total	0		0			63		0
% of Region Total	85%					63		156
Latin America	25	4 0%				26	5 7%	75
Argentina						1		
Brazil						3		
Chile						3		
Colombia						1		
Mexico						15		
Venezuela						3		
Sub Total	0		0			26		0
% of Region Total	90%					26		75

Aggressive Growth (Hagler Bailly Forecast)		
Average Annual Growth		Est 2015 Total Efficient (\$ million)
(1996 2000)	(2001 2015)	
15%	15%	224
		1
		24
		81
		20
		7
		5
		3
		27
		7
		42
		7
		224
		224
17 5%	15%	2,010
		301
		233
		27
		212
		99
		7
		25
		387
		532
		113
		75
		2 010
		2,010
15%	20 0%	1 693
		140
		269
		259
		1 024
		1 693
		1 693
17 5%	15 0%	403
		20
		20
		51
		7
		288
		18
		403
		403

US 100%

TOTAL						234		681
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US

4 330

Note: No individual country data obtained. Regional estimates only.



ENERGY EFFICIENT LIGHTING MARKET

**Conservative Growth
(TRACK GDP)**

**Aggressive Growth
(Hagler Bailly Forecast)**

Region/Country	Imports 1993 SITCs 7782+8124 (\$ million)	Average Annual Growth (1993 6)	Est 1996 Total Import Market (\$ million)	Est % Energy Efficient	Est % Imports	Est 1996 Total Efficient (\$ million)	Conservative Growth (TRACK GDP)	
							Average Annual Growth (1996 2015)	Est 2015 Total Efficient (\$ million)
Africa/Middle East								
Algeria	23	2 9%	25	5 0%	75 0%	2	4 3%	4
Egypt	31	4 5%	35	10 0%	75 0%	5	4 2%	10
Iran	33	3 2%	36	5 0%	75 0%	2	4 5%	6
Israel	35	5 7%	41	10 0%	75 0%	6	5 1%	14
Kuwait	32	9 3%	42	5 0%	75 0%	3	5 4%	8
Morocco	18	4 0%	20	5 0%	75 0%	1	5 2%	4
Nigeria	23	2 9%	25	5 0%	75 0%	2	4 3%	4
Saudi Arabia	152	1 6%	159	5 0%	75 0%	11	4 9%	26
South Africa	51	2 8%	55	5 0%	75 0%	4	5 4%	10
Turkey	45	1 1%	47	5 0%	75 0%	3	5 8%	9
U A E	85	3 7%	95	5 0%	75 0%	6	5 8%	18
Sub Total	528		581			44		113
% of Region Total	80%					55		141
Asia								
China	95	10 4%	128	15 0%	25 0%	77	7 4%	298
Hong Kong	633	4 9%	731	25 0%	90 0%	203	6 7%	696
India	31	6 3%	37	35 0%	10 0%	130	6 2%	409
Indonesia	30	7 1%	37	20 0%	50 0%	15	7 0%	53
Malaysia	56	8 4%	71	20 0%	50 0%	29	7 1%	105
Pakistan	33	5 0%	38	15 0%	50 0%	11	6 9%	41
Philippines	21	5 1%	24	20 0%	50 0%	10	6 7%	33
Singapore	162	8 4%	206	20 0%	50 0%	83	7 1%	304
South Korea	89	7 9%	112	20 0%	50 0%	45	7 1%	165
Taiwan	138	6 6%	167	20 0%	50 0%	67	7 0%	242
Thailand	57	8 3%	72	20 0%	50 0%	29	7 2%	109
Sub Total	1 345		1 624			698		2 454
% of Region Total	95%					734		2 583
Central/East Europe								
Czech Republic	34	3 6%	38	15 0%	10 0%	57	5 7%	163
Hungary	30	2 2%	32	15 0%	10 0%	48	4 3%	107
Poland	32	5 2%	37	15 0%	10 0%	56	4 3%	124
Russia	79	5 0%	68	15 0%	10 0%	102	5 7%	291
Sub Total	175		175			262		685
% of Region Total	85%					309		806
Latin America								
Argentina	44	4 2%	50	15 0%	50 0%	15	5 9%	44
Brazil	48	5 5%	56	15 0%	25 0%	34	5 9%	101
Chile	23	4 9%	27	20 0%	50 0%	11	5 8%	31
Colombia	15	5 1%	17	10 0%	50 0%	3	5 6%	10
Mexico	153	1 4%	160	20 0%	90 0%	35	5 8%	103
Venezuela	30	0 6%	29	10 0%	50 0%	6	4 3%	13
Sub Total	313		339			104		302
% of Region Total	90%					116		336

Average Annual Growth		Est 2015 Total Efficient (\$ million)
(1996 2000)	(2001 2015)	
4 0%	10 0%	8
10 0%	10 0%	29
5 0%	15 0%	24
15 0%	10 0%	40
10 0%	15 0%	33
10 0%	15 0%	16
10 0%	15 0%	20
10 0%	15 0%	127
10 0%	15 0%	44
25 0%	15 0%	62
15 0%	15 0%	90
		492
		616
30 0%	15 0%	1 782
30 0%	15 0%	4 717
10 0%	10 0%	797
15 0%	15 0%	210
15 0%	15 0%	406
25 0%	15 0%	228
25 0%	15 0%	194
20 0%	15 0%	1 393
7 0%	7 0%	162
25 0%	15 0%	1 328
15 0%	10 0%	212
		11 428
		12 030
10 0%	15 0%	676
25 0%	15 0%	954
25 0%	15 0%	1 110
10 0%	15 0%	1 210
		3 950
		4 648
25 0%	15 0%	297
20 0%	15 0%	571
20 0%	15 0%	179
10 0%	15 0%	41
25 0%	15 0%	704
25 0%	15 0%	117
		1 909
		2 121

US - 14 18%

US -

TOTAL						1 213		3 865
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19 414

APPENDIX B TECHNOLOGY MARKETS

1	Building Controls and HVAC	B-2
2	Building Envelope	B-6
3	Cogeneration	B-11
4	Household Appliances	B-13
5	Boilers	B-16
6	Industrial Process Controls	B-19
7	Industrial Motors and Adjustable Speed Drives	B-22
8	Lighting	B-26

CO

B I BUILDING CONTROLS AND HVAC

Building controls, also referred to as energy management systems, manage a building's energy-related systems to obtain the most economical and effective comfort levels. Comfort levels are a function of temperature, humidity, fresh air, lighting and security. Managing a building's energy consumption for optimal comfort requires understanding how the building consumes energy, how the occupants' needs are met, how the various energy conservation units and components interrelate, and how the external environment affects the building.

Building controls can be generally broken down into two categories: timers and controls. The major difference between timers and controls is that timers rely on predetermined functions and do not maintain a feedback loop to monitor conditions. Controls, on the other hand, measure existing conditions compared to preset values and make adjustments accordingly.

- ▶ Types of timers include mechanical, electromechanical, and electronic, the latter two are most commonly used. Timers are simpler to install, operate, and maintain and are cheaper than controls. They are also inflexible, however, timers cannot react to changing environments. Timers, therefore, have limited applications. The most important of these are the switching of HVAC lights, electric motors and electric heaters.
- ▶ Controls are used for more complex tasks, such as maintaining a constant temperature (thermostats), adjusting lights based on illumination levels (photocells) and occupancy levels (occupancy sensors), and controlling energy flows throughout an entire building (direct digital controls and energy management systems).

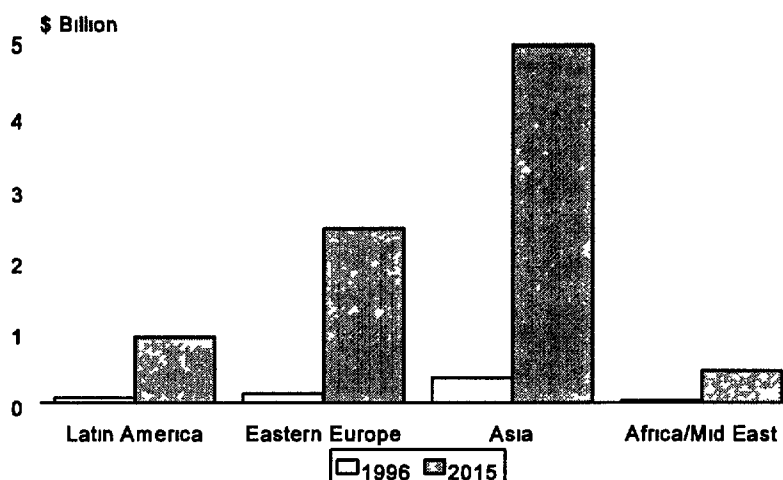
The most popular building automation systems are direct digital control (DDC) systems. DDC systems use microprocessors that perform control logic functions. Sensor data such as space temperature is digitally processed to calculate control commands that act directly on devices such as relays, valves, and dampers. The feedback is through either digital inputs (two-stage on/off) or analog inputs (variable value measured as a voltage or current signal). The advantages of DDC systems include reduced energy and maintenance costs, improved comfort levels and the ability to manage a system from one or more locations.

MARKET DEMAND

Building controls The market for building control systems in 1996 was an estimated \$572 million, the third smallest technology market segment in the overall energy efficiency market. The building controls market is projected to grow at a relatively rapid rate of 15.4% over the next two decades, under the aggressive growth scenario defined in the main body of this report. At that rate, the market size will be an estimated \$8.7 billion in 2015. Under the conservative growth scenario, the building controls market is projected to grow no faster than GDP, and reach an estimated \$1.7 billion in 2015.

Figure B-1

Building Controls Market



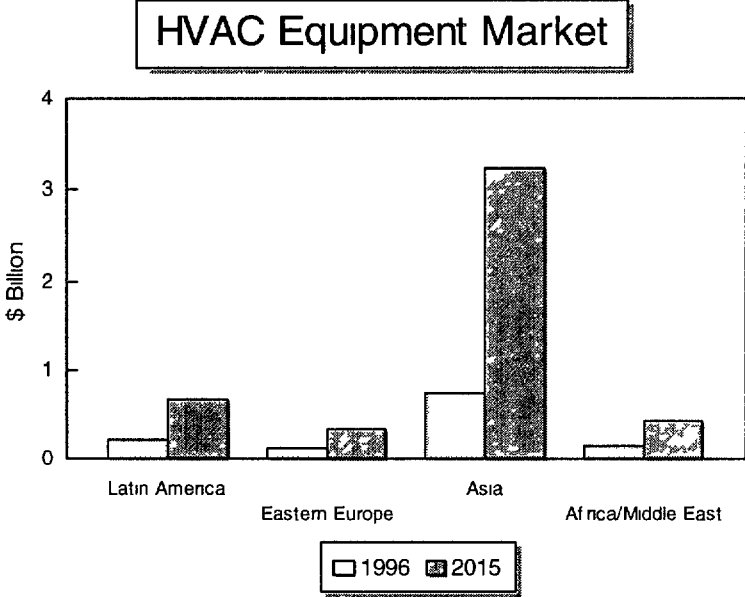
The most promising markets for building controls exist primarily in Asia, though the Eastern European market shows high potential in the coming years. Markets in developing countries are currently limited by the need for specialized engineering design work and building managers who have up-front experience with building control systems. A building manager with little experience in building control systems is unlikely to gain the full energy-saving potential of the system.

Likewise, engineers who are unaware of the benefits of the systems are unlikely to specify efficient building controls in their building designs.

HVAC The Air-Conditioning and Refrigeration Institute estimates that the global market (including industrialized countries) for air-conditioning and refrigeration equipment in 1996 was approximately \$40-45 billion. The markets in developed countries are mature, thus most growth is likely to occur in developing countries. Import statistics already show high sales of HVAC equipment in many developing countries. South Korea imported nearly \$1 billion worth of HVAC equipment in 1993. Saudi Arabia, Iran, Russia, Mexico and China each imported several hundred million dollars worth of HVAC equipment in the same year. In most developing countries, imports make up 60-90% of the total market. Therefore, import statistics give a fairly accurate picture of the total market size for HVAC equipment.

Nonetheless, the portion of the market that is energy-efficient remains small. The 1996 energy-efficient HVAC equipment market in developing countries was approximately \$1.2 billion. Energy-efficient HVAC equipment markets, though currently larger than markets for building controls, will experience only moderate growth in the future. The projected growth rate for the energy-efficient HVAC equipment market is approximately 7.3%, even under the aggressive growth scenario. Under the conservative growth scenario, the projected growth rate is 6.6%.

Figure B-2



COMPETITIVE ASSESSMENT

The major manufacturers of building controls and HVAC systems are Carrier, Honeywell, Johnson Controls, Landis & Gyr, McQuay International, Siebe Environmental Controls, and ABB

Controls manufacturers typically market their products to architects, developers, building managers, owners consulting engineers, contractors, distributors, utilities HVAC manufacturers and other OEMs

Honeywell Home and Building Control claims to be the undisputed worldwide leader” in providing comfort and convenience to customers through the provision of environmental controls Honeywell Home and Building Control’s products are found in more than 100 million residences and more than 5 million commercial buildings worldwide Honeywell makes one-third of the automatic control systems in the world Approximately 85% of sales are in existing building upgrades

The Switzerland-based Landis & Gyr is over 100 years old and is a leading supplier of mobile phones and other telecommunications products electronic management systems for buildings, and power meters for industrial use Its Building Control Division offers solutions for environmental management of residential and commercial premises This is the largest of Landis & Gyr’s three groups (the two others are Energy Management and Communications)

Siebe Environmental Controls (Loves Park IL) part of the British group Siebe plc, is a leader in the HVAC industry and carries one of the largest selections of building controls in the world It has a complete line of temperature control products and, with the acquisitions of Barber-Colman Environmental Controls and Robertshaw Control Systems, Siebe has over 200 years of combined experience in providing temperature and other environmental controls Siebe’s customer base includes Whirlpool, General Electric, Carrier, and Maytag

Siebe’s international group is dedicated to providing full heating, ventilating, and air conditioning systems capabilities on a worldwide basis Regional support centers in Europe, Asia, Latin America, Middle East, Oceania, and the United Kingdom work in conjunction with independent, local field offices to provide single source solutions for selection, engineering, installation, and administration of energy management systems Siebe has a global network of over 500 sales offices to ensure worldwide availability

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Africa Honeywell Europe has acquired ESS, a South African company specializing in energy and management control systems for commercial buildings (Jan 1995)

Asia

- ▶ *China* Honeywell has been doing business in China since 1979. In 1993, Honeywell formed a wholly-owned foreign enterprise in China, to provide sales, engineering, and service in Honeywell's Industrial Control and Home and Building Control businesses through four offices in China. More recently (February 1995), Honeywell announced plans to build its first manufacturing plant in China—a Home and Building Control factory—in Tianjin. The plant was expected to begin producing heating controls for apartment and commercial buildings (thermostats and valves) in late 1996.
- ▶ *Taiwan* The Taiwan Ministry of Economic Affairs signed a letter of intent with Landis & Gyr to form a strategic business alliance in a move to help the firm cultivate the Taiwan market and develop the country into a regional business hub to expand sales and services to the Asia-Pacific market (Oct 1995). In another joint venture with Fortune, Landis & Gyr acquired the Taiwanese company Powlier Energy Technology. The venture produces building lighting systems (Oct 1995).

Eastern Europe

- ▶ *Poland* Landis & Gyr Polska opened in 1993, offering a broad range of energy management systems, from homes to entire municipal districts. L&G Polska also took over a national network of 40 distributors, previously controlled by the Polish division of Austria's LG Gesellschaft. L&G Polska now also cooperates with the Krajowa Agencja Poszanowania Energii SA (energy conservation agency, as of July 1995).
- ▶ *Russia* Honeywell has had an office in St. Petersburg since 1992. It has provided environmental control systems to Russia's State Hermitage Museum, the Kremlin Palace of Congress, and the Moscow World Trade Center.

Latin America

- *Brazil* Johnson Controls has been operating in Brazil for ten years and has 180 employees throughout the country.
- *Chile* Honeywell and Lutron have been providing lighting controls in Chile for some time. Johnson Controls entered the market in 1996. Johnson Controls and Honeywell are interested in broadening their focus to include overall building energy management systems rather than just lighting systems.
- *Mexico* The largest market in Mexico is in the new commercial sector. The retrofit market is currently extremely small. Honeywell established a plant in Tijuana in 1985 to assemble heating and air conditioning controls for the residential sector.

MARKET OPPORTUNITIES

In general, market growth of building controls and HVAC systems parallels construction activity. Section 2 of the main body of this report contains a discussion of construction market trends and the current boom taking place primarily in Asia. Efficient HVAC equipment markets are likely to benefit from this trend, as new construction and building requires the installation of these products and local engineers and architects become aware of their benefits. The same is true for building controls, though because of their relative complexity, growth is likely to be less strong. The traditional growth for building controls has been more in the retrofit market, a trend which will continue mostly in Eastern Europe and Russia. Energy-efficient air conditioning equipment is likely to enjoy some success in the retrofit market as well, as CBC-producing units are slowly replaced with CBC-free systems, which are also typically more efficient.

B 2 BUILDING ENVELOPE

Energy conservation in buildings is achieved in part through optimal design of the building envelope. A building envelope defines the building's heating, cooling and lighting loads. There are two important measures used to control these loads: windows and insulation.

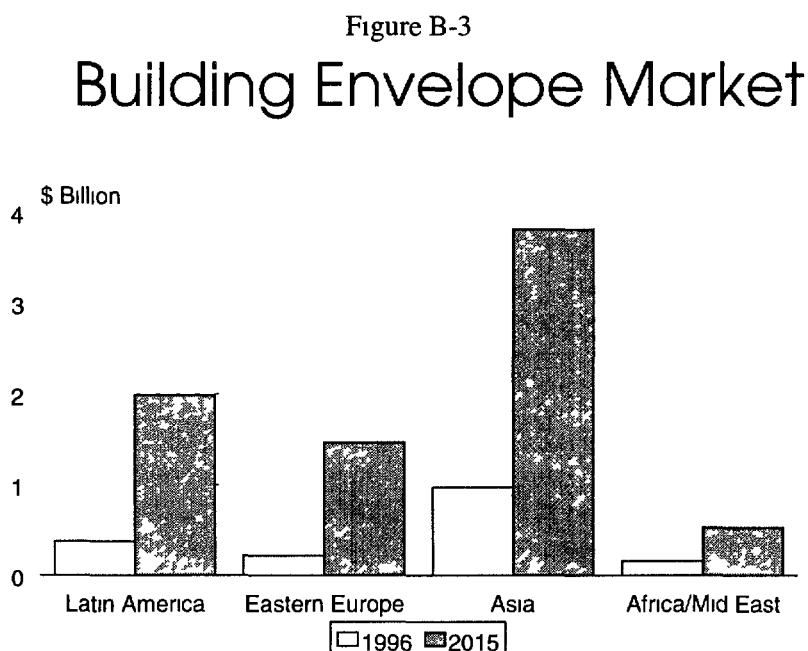
Windows Windows can be a major source of heat loss in the winter and heat gain in the summer, and thus present significant opportunities to improve the energy efficiency levels of a building. The energy performance of a window typically is measured in terms of its R-value. "R" stands for resistance to heat flow. If a window's R-value is high, less heat will be lost than through a window with a lower R-value. Window R-values range from 0.9 to 3.0. Different combinations of frame style, frame material and glazing can lead to different levels of energy efficiency.

Insulation Building insulation resists the flow of heat. By reducing heat flow through proper levels of insulation, less energy is needed to maintain a constant temperature inside a building. Insulation is also useful for controlling sound and moisture levels. The comfort level of a building is improved with insulation in several ways: reduced drafts, warmer floors, and uniform temperatures. Fiberglass insulation is also identified and labeled by R-value. The higher the R-value, the greater the insulating power. It is important to note that it is the R-value of installed insulation that is important, rather than the R-value per inch of a fiberglass product. This is true for two reasons. First, loose-fill insulation can be installed to any R-value, thereby achieving the desired level of energy efficiency. Second, batts of insulation can be layered to achieve a higher installed R-value.

MARKET DEMAND

Market Size

The market for building envelope technologies in 1996 was an estimated \$1.7 billion, accounting for 18% of the total energy efficiency market. Assuming a rate of growth of 8.3% under the aggressive growth scenario, the building envelope market is expected to total \$7.8 billion by 2015. Even under the conservative growth scenario, based on a growth rate that tracks GDP, the market is likely to total \$5.6 billion.



The building envelope market in Asia is the largest, reflecting the large construction markets that exist in many Asian countries. Figure B-3 presents both recent and future market estimates by region. Although Asia dominates in terms of absolute size, Eastern Europe will experience the fastest growth at an average of 13.5% per year. In terms of single-country markets, the size of the Brazilian market is similar to that of several of the larger Asian country markets including China, India, and Indonesia. In 2015, under the aggressive growth scenario, the top four country markets will be South Korea (\$940 million), Brazil (\$930 million), China (\$720 million), and Russia (\$690 million).

The building envelope market, like the HVAC equipment and building controls markets, is highly dependent on trends in the construction market. Presently, the construction sector is struggling to keep up with the pace of population and commercial growth, and the demand for business office space, hotels, shopping centers, hospitals, and schools throughout the developing world. Thus, the outlook for building envelope technologies is quite positive.

Nonetheless, there is a very low penetration rate in general in developing countries for energy-efficient building envelope technologies. Even in the U.S., where insulation enjoys widespread use, the percentage of insulation defined as energy-efficient makes up a mere 0.3% of the total construction market, while energy-efficient windows are only 0.5%. The estimates of market penetration assumed for this report fall into three ranges: low (0.5% of the market is energy-efficient), average (1.0%), and high (2.0%). Penetration is estimated to be highest in Eastern Europe on average, and lowest in Africa.

The market for energy-efficient windows is relatively nascent in developing countries. The majority of windows sold are made of aluminum and are generally single-glazed. Reflective glass is the one efficient window type that is frequently used in commercial construction, though this is probably due more to

aesthetic appeal than to recognition of its thermal qualities. The majority of demand for energy-efficient windows exists in Asia and Latin America.

Market Segmentation

The building envelope market can be segmented by residential housing, commercial (and public) buildings, and industrial facilities. The discussion below emphasizes the residential and commercial segments, which represent the largest potential markets in developing countries for the period 1997 through 2015.

Commercial The commercial segment offers the greatest potential for sales of both insulation and windows. There are several reasons for this. First, as was mentioned previously, commercial construction is booming in many developing countries, assuring a minimum level of demand for building envelope technologies. Second, commercial construction practices in the developing world generally are similar to construction practices in developed countries. This may be partly as a result of the increase in international investors and multinational corporation sponsorship of projects in developing countries. Commercial builders for these projects increasingly demand high-quality materials and equipment. As a result, international insulation manufacturers typically target large new commercial and institutional construction projects in developing countries. Third, the commercial sector is a more concentrated market niche than the smaller and more widely-dispersed housing market.

Residential There is an emerging mid-scale housing market, especially in Asia and Eastern Europe. However, current consumption of insulation and windows by the residential sector is limited. The additional cost of installing insulation, coupled with the general lack of awareness of the cooling benefits of insulation, contribute to the low penetration rates of insulation in developing countries. Many homes in Latin America, for example, are cooled by fans or by the opening of windows. In addition, insulation batts made for the western-style, stick-frame home common in developed countries are not suitable for housing units found in Latin America, Asia, and Eastern Europe. In those regions, housing units are commonly constructed of concrete, block, and brick. Finally, residential demand for wood windows, a particularly efficient type of window, comes from only the top 5% of all households worldwide, according to industry experts.

COMPETITIVE ASSESSMENT

Window market The global window market is characterized by multiple manufacturers of a variety of frame types. Competition for sales is both among manufacturers of the same window type and among different window types that can fulfill the same application. Aluminum window makers presently dominate the markets in developing countries. One of the larger companies is the Kawneer Company which does business in 95 countries around the globe.

Manufacturers of energy-efficient wood windows include Marvin, Andersen, Pella, Weather Shield, Pozzi and Hurd. Marvin and Andersen probably account for two-thirds of U.S. manufacturers' international wood window sales. Marvin Windows exports its products to Latin America, Asia, Eastern Europe, and

the Middle East. However, only 5 to 10% of its business is international, and Japan and Canada account for two-thirds of those sales. A similar percentage of Andersen's sales are international, and they too are predominantly selling in Canada and Japan (the only developing country Andersen is active in is Mexico). A handful of glazed wood window manufacturers are scattered throughout the developing world, but their products tend to be inferior in quality.

There is very limited manufacturing of energy-efficient windows in developing countries, primarily because demand is limited. The greatest demand in developing countries exists for aluminum windows, and not wood. First-cost is an important factor in the decision-making process of developing country customers. This creates a barrier for glazed wood windows given their higher prices compared to their aluminum competition. In fact, the only windows that are generally more expensive than wood windows are vinyl windows, and these are not present in these markets due to cost and the bias discussed above.

In the market for wood windows, Pella's strongest developing world business is in Latin America. Pella products can be found in almost every country in the region. The Philippines has also provided a stable market for the company. While windows are sold to other countries in the world, these are mostly on a project-by-project basis.

Marvin fabricates all of its products in the United States, and only after orders have been placed with the company. Since there are few manufacturing sites in developing countries, most demand is met through imports. Window manufacturers rely heavily on local distributors and dealers, which tend to have strong connections to the building industry.

Wood windows are typically shipped with the glass panes already installed. This ensures the product's ultimate performance and results in levels of quality matching wood windows sold in developed countries. Aluminum windows, however, are shipped without any glass. The major implication of this is that uneven levels of energy efficiency are achieved given the unpredictable, but generally lower quality of the installed final product. This problem is exacerbated by the fact that low-emissivity glass is rarely manufactured in the developing world and that locally sourced glass is of inferior quality, though Korea has made some progress in this area. Windows are also commonly shipped as part of prefabricated buildings. One of the larger wood window manufacturers reported that close to one-third of its international sales were made up of windows integrated into prefabricated buildings.

Insulation market The global fiberglass insulation market is a virtual oligopoly dominated by the two firms Owens-Corning and Saint-Gobain. A third major manufacturer, Schuller International, has yet to play a significant role in developing country markets. Although market shares are difficult to determine, Owens-Corning may account for as much as half the market. In addition to these three firms, there are also a number of local participants in the insulation industry. For example, fiberglass manufacturers (typically using licensed technology) exist in South Africa, Australia, India, Japan, Korea, Philippines, New Zealand, Taiwan, Thailand, Turkey, Argentina, Brazil, Colombia, and Venezuela.

Since transport of bulky insulation products is expensive, local manufacturing facilities are necessary to building a local presence. As a result, Owens-Corning has 80 manufacturing facilities worldwide. The

company also enters new markets through subsidiaries, joint ventures, and licensing agreements. Saint-Gobain is present in Africa, the Americas, Asia, and Eastern Europe.

Similar to the window industry, distribution of building insulation is done primarily through distributors that supply the construction industry. Building contractors, property owners and managers are also an important link in the distribution chain. Specialty insulation firms whose products are used for items such as refrigerators and air-conditioners sell mostly to OEMs through an agent.

Energy efficiency is a critical component of marketing and distribution of insulation products. For example, Owens-Corning strives to educate potential users of the thermal benefits of its products through a process it calls "seeding" the market. To begin with, the company recruits local engineers for training in the U.S. Once the local engineers understand the thermal benefits of insulation, they are better able to persuade specification engineers and architects in their own country to use Owens-Corning materials. In addition, product and third-party literature is circulated to local stakeholders such as energy ministers, architects, engineers, and builders to convince them of the benefits of Owens-Corning's thermal products. The company sees the use of NAIMA and other third party literature as critical because of the objectivity it brings to the argument.

MARKET OPPORTUNITIES AND BARRIERS

Opportunities

Manufacturers first target the commercial sector where demand is concentrated and more easily tapped. Window and insulation manufacturers have initially targeted the commercial sector where there are fewer barriers to market entry, as discussed in more detail above. Cost is less of a barrier in commercial projects since one project can generate significant demand for a single product, reducing the unit costs.

Consumers are increasingly attentive to product quality, creating more opportunities for high quality energy-efficient products. Previous experience with poor quality products, particularly windows, and the frequency of repairs associated with them is driving sales of high-quality windows and insulation. Consumers are gradually gaining an understanding of the concept of life-cycle costs.

Non-energy related factors are initial market drivers in many developing countries. Noise and dust infiltration are critical factors in the decision to purchase windows. Noise levels in many of the larger cities in Latin America and Asia are quite high. Wood window manufacturers report that noise reduction is one of the leading drivers for its products. Better seals and multiple-pane windows can reduce external noise. Prevention of dust infiltration is also a strongly desirable characteristic in windows in Latin America and Asia. Poor-quality seals allow significant air and dust infiltration through the frame. This is particularly noticeable in many regions that rely on coal as an energy source.

The use of building energy codes is increasing as countries recognize the need for energy conservation. Many countries are adopting building energy codes to improve building efficiency. Countries with

mandatory codes for some or all building types (i.e. residential, commercial) include Israel, Kuwait, Hungary, Czech Republic, Chile, China, South Korea, Philippines, Thailand, South Africa, and Saudi Arabia. There are essentially no standards that apply specifically to windows in the developing world. Thailand, however, is considering the introduction of a window standard in the future. Marvin Windows has worked with the Korean and Japanese governments in efforts to develop window standards.

Barriers

There is low awareness of the beneficial qualities of building envelope technologies Awareness of the benefits of building envelope technologies is low in developing countries. There is little understanding that insulation can keep buildings cool, contributing to a low penetration rate in warmer climates. There is also a misconception concerning the product appearance. Insulation produced by developing countries using older technology means that the product must be quite thick to achieve the same R-value as advanced products from developed countries. Therefore, the thinner, higher efficiency products suffer from the misconception that they are somehow "thinner" and therefore less effective. Certain types of windows also are hindered by misconceptions. Many vinyl windows are state-of-the-art technology, but in Latin America the general view of plastic products is that they are of lesser quality. As a result, consumers are often biased against more sophisticated materials based solely on their physical appearance.

B.3 COGENERATION

Cogeneration is the sequential production of electrical or mechanical power and process heat from the same primary fossil fuel. Depending on the market sectors in which cogeneration is used, it may be termed in-plant power generation, dual energy use, water (or reject) heat utilization, district heating (only with electricity generation), and total energy (or integrated energy/utility).

Cogeneration basically means that waste heat from the production of electricity or mechanical power is utilized within the plant where there is a demand for a low temperature heat source. The low temperature heat source may be exhaust from an internal combustion engine, a gas turbine power plant, or low pressure steam from a steam turbine.

The fuel required for simultaneously producing power and process heat in an integrated (cogeneration) system is less than the sum of the fuels required to operate two systems at the same site producing power and process heat separately.

Facilities requiring heat and electricity that are in operation for most of the day and night are excellent candidates for cogeneration systems. In many developing nations where irregular voltages, brownouts, and blackouts are common, instead of installing a standby generator, it may make more economic sense for an industry that uses electricity and process steam to consider a cogeneration system. The cogeneration plant will generate electricity to meet the plant's electricity demand and process steam, and may sell the excess electricity produced to the national grid, bringing in revenues to the industry. This assumes that there are laws in place to encourage private power production in the country.

MARKET DEMAND

The market for cogeneration equipment in developing countries in 1996 was an estimated at \$750 million. Growth over the next two decades is expected to be slow to moderate except in specific countries. The cogeneration market is expected to be virtually non-existent in Africa and the Middle East (mainly due to climate considerations). Under the aggressive growth scenario, the fastest growth in cogeneration will be in Turkey, followed by India, Russia, Argentina, Brazil, and Venezuela. The largest absolute markets in 1996 existed in China, Thailand and Brazil. This will continue to be the case in 2015, according to the aggressive growth scenario. The total size of the market is expected to reach \$1,931 million by 2015, with Asia comprising the largest regional segment at \$977 million. The Latin American market will also be important, at an estimated value of \$588 million in 2015.

MARKET OPPORTUNITIES AND BARRIERS

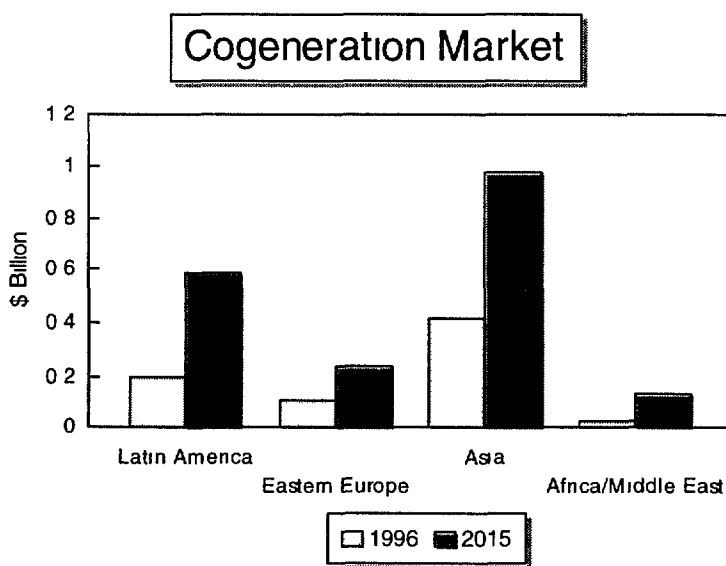
Cogeneration has a wide variety of industrial, commercial, and residential applications. Possible candidate facilities for installing cogeneration systems include the following: computer centers, convention centers, hospitals, hotels, laundries, chemical industries, refrigeration plants, high rise office buildings, high rise apartment complexes, shopping centers, oil refineries, and electric power plants.

Accelerating demand for electricity increases the likelihood of brownouts and blackouts. Many electrical customers in developing countries experience brownouts and blackouts on a regular basis. These can be costly in terms of productivity and time losses. Cogeneration provides an alternative to less efficient and more costly backup generators. As developing countries experience increasing pressure on their limited power supplies from an accelerating demand for electricity, cogeneration will become a more attractive option.

Cogeneration has limited application due to climate variations. Cogeneration can only be utilized in regions and countries which have need for waste heat. Many developing countries enjoy warm climates and therefore have limited use for the benefits of cogeneration.

Installation of cogeneration facilities is dependent on regulatory requirements for independent power production. Laws and regulations that

Figure B-4



encourage private sector power production are crucial to the success of cogeneration. Currently, there are often regulatory or legal barriers to cogeneration in developing countries. These need to be modified to allow further penetration into sectors and industries that could benefit from the cost advantages of cogeneration.

B 4 HOUSEHOLD APPLIANCES

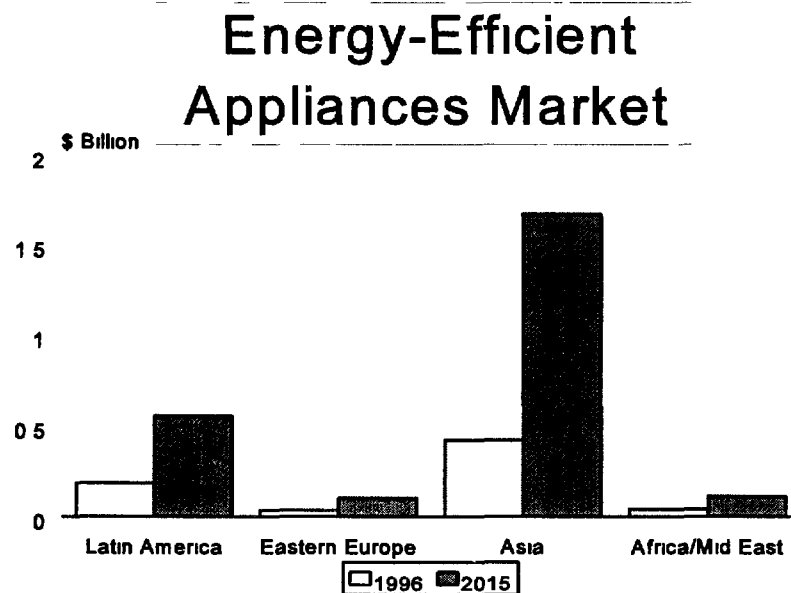
Most consumers in developing countries own or can afford to buy only a limited range of household appliances. Although the full range of major household appliances are sold in Asia, Eastern Europe, Latin America and Africa, refrigerators dominate overall appliance sales. In fact, refrigerators typically compete with radios to be the first electrical appliance purchased by a household once lighting has been obtained. Clothes washers, stoves, and room air-conditioners are also popular, although the desired styles and level of demand vary from region to region.

Residential consumption of electricity is increasing in many developing countries. In Thailand's rural households, refrigerators are the largest source of electricity consumption. In Brazil, refrigerators consume 32% of residential electricity.

MARKET DEMAND

The market for energy-efficient household appliances in developing countries is an estimated \$680 million. Market growth over the next two decades will be moderate. By 2015 the energy-efficient appliance market will likely range from \$2.3-2.4 billion. Since energy-efficient appliances tend to be more expensive than less efficient models, the market growth will be more or less dependent on increases in disposable incomes. (The exception will be those countries that introduce minimum efficiency standards for appliances which will force lower quality, cheaper models out of the market.)

Figure B-5



Asia, the largest regional market, accounts for more than 62% of the total market. In 1993 the region imported more than \$3 billion in residential appliances. Hong Kong was the largest importer, though many of these goods may ultimately have been sold to consumers in mainland China. Chinese imports of appliances are relatively small, reflecting the large local manufacturing base.

The other three regions—Latin America, Eastern Europe, and Africa/Middle East—trail far behind the Asia market in terms of size. Although Latin America accounts for 6% of the global home appliance market, the market for energy-efficient appliances is estimated at only \$185 million. Eastern Europe's market for energy-efficient appliances is only \$34 million and Africa's is \$40 million. The lower estimate for Eastern Europe reflects a local manufacturing base, which produces low quality, inefficient models, as well as a large existing stock of appliances with long life-cycles. Africa, on the other hand, relies more on imports which creates more opportunities for efficient models. In addition, the number of consumers is growing in Africa.

COMPETITIVE ASSESSMENT

The household appliance industry is dominated by a few multinational firms that market their products on a global basis. Six of the largest international manufacturers of white goods are Whirlpool, GE Appliances, Maytag Appliances, and Raytheon of the U.S., Electrolux of Sweden, and Siemens of Germany. These companies market their appliances under a variety of brand names. For example, Whirlpool sells products under six different brand names, including KitchenAid, Philips and Kenmore.

Nevertheless, local manufacturers still play a role in the markets of many developing countries. In China, for example, there were over 200 local manufacturers at the end of the 1980s. Industry consolidation has since swept through the Chinese industry, reducing the number of appliance manufacturers to approximately 50 firms. Brazil's market is likewise dominated by local production. Multibras S.A. is the largest producer and marketer of major appliances in Brazil, with total annual sales of \$1.5 billion. The large foreign firms commonly team with domestic firms to obtain low-cost labor, immediate local infrastructure and knowledge, and quick access to markets.

Household appliances are typically distributed through local agents or exclusive distributors who operate as wholesalers, stocking orders for a large community of independent retailers. These distributors are typically responsible for importing, selling, installing, and servicing the products of the manufacturers they represent. The exporting multinational will typically provide training for its distributors who are responsible for maintaining the brand's image, as well as close ties to the consumer.

Household appliances are imported as well as manufactured in many developing countries. Appliances are imported by developing countries as complete, ready-to-use products, sometimes requiring some adaptation or assembly before sale, or as kits that can be assembled by local manufacturing facilities. Some countries, such as Pakistan, offer lower import tariffs and other incentives for appliances being imported in parts rather than as whole products. This is part of a strategy to promote domestic industry. While the domestically-produced appliances of some countries have achieved international standards and are

exported throughout the world (e.g., a number of Korean brands), the majority of these products are of significantly lesser quality than U.S., Japanese and Western European products. The main reasons for this are the use of outdated technology and less-expensive, poor quality materials.

MARKET OPPORTUNITIES AND BARRIERS

Electric appliances are penetrating economies earlier in the development process As Table B-1 illustrates, the percentage of households that own a refrigerator is quite high in many developing countries. High penetration rates of appliances are a key factor in the rapid growth of these markets for several reasons. First, women are starting to move into the formal workplace at an increasing rate. Not only does this boost a household's income, it also increases the need for more efficient, less labor-intensive appliances. The purchase of a refrigerator makes food storage possible and thus reduces the number of trips required to the store or local market to buy food. Second, modern manufacturing techniques and improved materials have reduced the real cost of consumer goods, and more developed global distribution systems have lowered the cost of goods in retail markets. Finally, a number of major appliance manufacturers report that ownership of refrigerators and other white goods—especially imported ones—is a sign of status in many developing countries. This symbolism, combined with increased access, is driving consumers to purchase appliances before reaching the income thresholds usually required in the past. Nonetheless, sales of energy-efficient appliances will lag behind sales of standard appliances. Price remains a critical factor in purchasing decisions.

The phase-out of CFC-using refrigerators will continue, creating a sizable replacement market A major opportunity for energy-efficient appliances is in the replacement of older, CFC-using equipment. As CFC-using technologies are replaced for environmental reasons or simply because maintenance becomes difficult with the phasing out of CFCs, the opportunity exists for energy-efficient refrigerators to capture greater market share. Two countries, Chile and China, have initiated programs aimed at increasing the penetration level of CFC-free appliances.

Brazil	60%
Chile	55%
China	10%
Philippines	30%
Poland	100%
South Korea	100%
Thailand	87%
Taiwan	100%

- ▶ Chile's government issues the "Ozone Label" to encourage customers to purchase ozone-friendly products. As a result, consumers have begun replacing their existing refrigerators in anticipation of reduced availability of CFCs.

- ▶ The U S Environmental Protection Agency and the Chinese Council of Light Industry jointly developed the Sino-U S Super Energy-efficient CBC-Free Refrigerator. The goal was to produce a new generation of CBC-free refrigerators with energy consumption of less than half the current models. Qingdao Haier Group (a Chinese refrigerator manufacturer) was selected to develop the new model. The company, using German Leibherr technology, produced its first 200 refrigerators in December 1993. These refrigerators demonstrated energy savings of 42%. The refrigerator is comparable in price to current models.

Energy standards and labeling are relatively scarce in developing countries. A significant barrier to higher penetration of energy-efficient appliances is the absence of efficiency standards and labeling programs in developing countries. Price remains a critical factor in most purchasing decisions. Thus, there will continue to be a strong bias against the more expensive energy-efficient models. Asia and Latin America have made the greatest strides toward developing standards and labeling programs. China, South Korea and Taiwan all have minimum efficiency standards for refrigerators, while Taiwan and China have standards for clothes washers.

B 5 BOILERS

Boilers, which produce steam, have two principal applications: to fuel steam turbines in power generation, and to create thermal energy for industrial processes. The three common types of boilers enjoying widespread use are conventional steam boilers, circulating fluidized bed (CFB) boilers, and waste heat recovery boilers.

Conventional steam boilers are most common in developing countries; they are also the least efficient type of boiler. In industrialized countries, the standard efficiency for this type of boiler is around 88%, and the overall efficiency of power generation using this technology hovers around 38% (The addition of a scrubber lowers the efficiency to around 30%.) The efficiency of a power plant using CFB technology is approximately 36%. A system using waste heat recovery boilers can achieve efficiencies as high as 50%.

Boiler systems in developing countries are typically much less efficient than those installed in developed countries. Many boiler manufacturers feel that low levels of boiler efficiency in developing countries are partially due to the average age of the installed base of boilers in these countries. In India, for example, it is estimated that there are around 245 power boilers, of which 130 units are between the ages of 25 and 30 years old. Replacement of developing country boilers could effectively increase the operational efficiency by 5 to 15%. The World Bank has launched a program to upgrade the efficiency and environmental performance of China's small- and medium-sized boiler systems.

The energy efficiency of boilers is dependent on two main factors. First, the level of efficiency will be better when greater sensitivity is shown during the design and procurement stage to the pre-heat supply, the burner characteristics, and the insulation of major boiler components and heating pipes. Second, additional improvements in operating efficiency will also be obtained through regular maintenance of distribution circuits and cleaning of burner parts.

U S and Western European manufacturers claim that all of their boilers are ‘efficient’ simply because they have made considerable improvements in the design and manufacturing of boiler systems over the years. When asked to compare the boilers manufactured by their developing country counterparts, many U S manufacturers claim that their product is inherently more efficient.

MARKET DEMAND

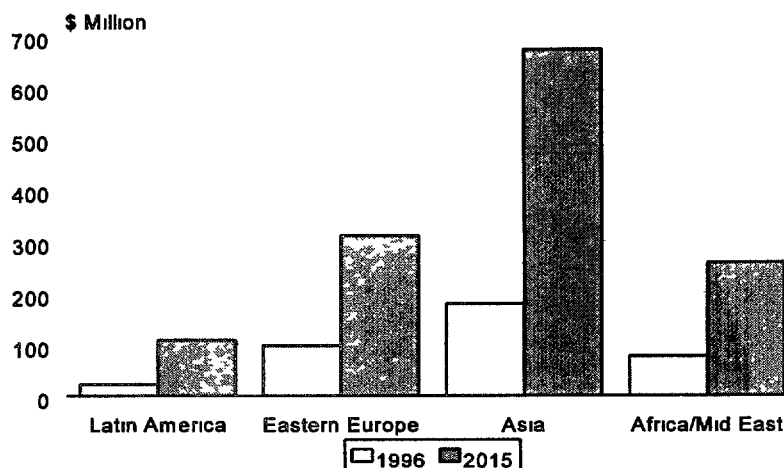
The market for industrial and utility boilers in 1996 was an estimated \$337 million, the second smallest market segment in the overall energy efficiency market. The boiler market is expected to experience only moderate growth—6.9% per year—over the next two decades. The market size in 2015 will range from \$1.2 - 1.4 billion.

Promising markets for boilers exist in China, Morocco, Czech Republic, Poland and Indonesia. China may well have the largest boiler market in the world. Local production of boilers accounts for a significant share of the market in China. For example, Babcock & Wilcox has supplied more than 10,000 MW of boiler capacity to China since 1986 through a number of manufacturing joint ventures. Babcock and Wilcox Beijing Boiler Works, a joint venture with the Beijing Boiler Works, was formed in 1986 and is the company’s largest

manufacturing facility outside the U S. The plant produces conventional boilers (300-500 MW) and industrial CFB technology. A number of notable local firms in the Chinese boiler market are China National Electric, a manufacturer of energy-efficient boilers, and the National Information Centre of Environmental Science and Technology which manufactures energy-efficient CFB combustion boilers.

Figure B-6

Industry and Utility Boiler Market



COMPETITIVE ASSESSMENT

Since the late 1980s, there have been a number of major mergers in the boiler industry, reducing the number of independent boiler manufacturers. The largest American boiler manufacturer, Combustion Engineering, was acquired by Sweden’s Asea Brown Boveri (ABB) Group in 1990. Deutsche Babcock merged with Lentjes in 1992. More recently, Foster Wheeler Corporation acquired Ahlstrom Pyropower, a leading manufacturer of fluidized bed combustion technology.

There are six major international players in addition to more than 40 smaller companies worldwide that are capable of producing utility-scale boilers. Many of these firms are increasingly active in international markets. The six key players are ABB Combustion Engineering, Babcock & Wilcox Power Generation Group, Deutsche Babcock, Foster Wheeler Energy Corporation, Mitsubishi Heavy Industries, and Mitsui-Babcock Energy. Each has a significant share of the market.¹

A common strategy among the international boiler manufacturers is to develop local operations through acquisitions, joint ventures and licensing. These companies are teaming with local firms to gain immediate access, broad coverage and extensive knowledge of the local market. This allows the large international firms to compete with local firms offering less expensive (but often lower quality) technologies.

The boiler industry has suffered from chronic overcapacity, a problem that has periodically prompted government intervention. A 1988 study found that the European boiler industry, comprised of 20 to 30 manufacturing companies, was operating at 20% capacity. The trend toward consolidation, combined with booming demand in developing countries, has alleviated the problem to some degree. Competition from local low-cost manufacturers, however, has kept prices down, partially as a result of lingering national buying preferences among major customers.

The competitive market situation has forced boiler manufacturers to make greater efforts to customize and improve the service they offer to their customers. For example, ABB's strategy is to offer turnkey packages of virtually everything needed to build a power station. Foster Wheeler also provides a full range of service to customers, including project development done by Foster Wheeler Power Systems and financing done by Foster Wheeler Corporation. Babcock and Wilcox will also provide turnkey services, assist in project development, and arrange financing for its customers.

MARKET OPPORTUNITIES

Reducing the environmental impacts of coal-fired generation plants will drive sales for clean coal technologies. Global demand for boilers is increasingly shifting to CFB boilers. Not only are CFBs more efficient than conventional boilers, they also are less harmful to the environment. CFB boilers were designed to resolve the environmental problems posed by more conventional designs. CFBs are able to cut SO_x emissions by 90% or more. NO_x emissions are also reduced. Other clean coal technologies include traditional pulverized coal boilers with scrubbers.

Fuels of all types and qualities can be used with the CFB design, making it very attractive in regions with an abundance of low-quality coal. CFB is in high demand in China, despite the great distances that coal must be transported in order to reach the generation plants supplying power to large coastal populations. Eastern Europe also possesses large reserves of poor-quality coal. That, combined with the fact that the

¹It should be noted that although the Babcock companies were related in the past, there is no connection now.

existing boiler equipment is quite old, provides a significant opportunity for the clean-coal technologies, especially CFB

Latin America also offers opportunities for CFB technology, though to a lesser extent. Latin America has very few coal resources and has historically relied on hydropower for its generation needs. CFB does have some potential, specifically with such fuels as petroleum coke, orimulsion, biomass, and wastes. Nevertheless, the region is looking increasingly to natural gas, a resource that essentially has been ignored in the past. The largest market in the region may, therefore, be for waste heat recovery.

The demand for utility-sized boilers will follow growth in electricity demand The growth of electricity demand in almost all developing countries creates an opportunity for efficient boilers to have a dual benefit. Their use by utilities responding to increasing pressure for generation allows that need to be met in a way that itself energy-efficient.

Industrial sector trends such as privatization and global competition will fuel demand for boilers in certain industries Trends such as privatization and increased global competition force companies to seek ways to improve operational efficiency. This is potentially beneficial to the boiler market if industries affected by these trends seek to optimize their industrial systems. Key industries that rely on boilers for steam and power include the pulp and paper, petrochemical, sugar, chemical, food processing and textile industries. The pulp and paper industry is strong in Asia and Latin America. The Middle East, Indonesia, Mexico, and Venezuela all have established petroleum industries. A number of the former Soviet countries also have potential in this area. The sugar industry is particularly prevalent in India and Mexico.

B.6 INDUSTRIAL PROCESS CONTROLS

The costs of process controls have dropped so dramatically in recent years that almost every process in the developing world can serve to benefit with a reasonable payback from their use. Process controls are commonly used in a number of industrial processes, including

- ▶ evaporation and drying
- ▶ combustion in boilers, furnaces and kilns
- ▶ compression of air or other gases

Since process controls have a wide range of application they are found in nearly all industries. In developing countries energy-intensive industries such as utilities, refineries or textile plants are the primary users of automatic process controls. The industrial processes listed above can be significant sources for wasted energy if not properly controlled. These processes are discussed in more detail below.

- ▶ ***Drying/evaporation*** Drying is a process through which moisture is removed from a solid material by exposure to unsaturated air or gas. (This may or may not include heat.) Evaporation is the separation of a liquid from a solid by the application of heat in the absence of air or another non-condensable gas. Process controls can reduce wasted energy by eliminating over-drying, optimizing

the air flow rate for drying and recycling exhaust air. Drying and evaporation processes primarily are found in textile manufacturing, food and food by-product processing, chemical production, and paper manufacturing.

- ▶ **Combustion** A poor air-to-fuel ratio in the combustion process results in wasted energy. Process controls manage the air and fuel flow for an optimal combustion process.
- ▶ **Compression** Compressors are a major source of electricity consumption in the industrial sector. Air or other gases are compressed for instrument and process use, to provide refrigeration, or to transport gases. Process controls in compression play a similar role to combustion processes, managing the air flow and pressure for optimal compression.

An automatic control system measures a variable condition which is then compared to data points for the desired conditions. A control system will initiate actions to reduce the differences between the two sets of data. The advantage of an automatic control system over a manual control system is the continuous monitoring of conditions and the ability to initiate the necessary changes to ensure that the process operates in the most efficient and effective manner. Automatic control systems also offer rapid response times. However, they are more expensive and require calibration and maintenance on a regular basis. The additional costs are generally offset by reductions in annual facility operating costs.

District heating is an attractive market niche for process controls outside of the industrial market. In China and many Eastern European countries, district heating is a means to efficiently provide heat to the residential population while lessening environmental damage that would result from the use of millions of small coal-burning furnaces. This process can also be wasteful, however, if the proper process controls are not used. Controls can be applied at the point of generation, distribution, or heat consumption. Eastern European district heating systems, some of which consume two to three times more energy than comparable systems in Western Europe, have typically realized savings of 20 to 30% with the introduction of process controls.

MARKET DEMAND

More and more developing countries are using process controls. The total market value for process controls in developing countries was valued at \$1.9 billion in 1996. The market is expected to grow only moderately over the next two decades, even under the aggressive growth scenario, averaging 6.6% on an annual basis. Growth rates will be higher through 2000 and then will likely track economic growth until 2015. By 2015 the value of the market is expected to range from \$6.1-6.5 billion under the aggressive growth scenario.

Most market demand in developing countries is met through imports. Key import markets (in terms of value of imports) include South Korea, China, Taiwan, and Singapore. Korea is quite advanced in its use of process controls. Chinese companies, on the other hand, are installing *basic* process controls on *newer* machines. Indian manufacturers, meanwhile, are installing *used* machines with very *advanced* automation systems.

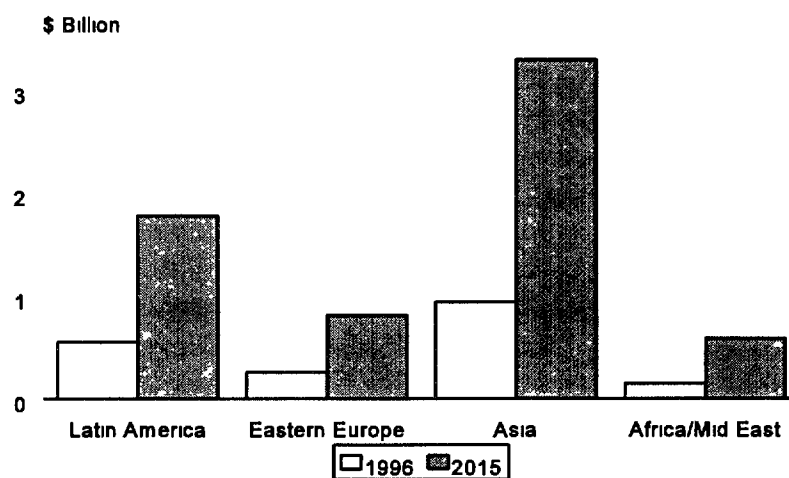
COMPETITIVE ASSESSMENT

The leading international manufacturers of process controls are Honeywell, Asea Brown Boveri (ABB), Siemens, General Electric, Siebe, and Landis & Gyr. Yokogawa is also a major player, especially in Asia.

Honeywell makes one-third of the automatic control systems sold worldwide. Its customers include appliance manufacturers, chemical plants, automotive companies, computer and business equipment manufacturers, food processing plants, medical equipment manufacturers, oil and gas producers, pharmaceutical companies, pulp-and-paper mills, refining and petrochemical firms, textile manufacturers, and utilities. Twenty-four of the largest oil refiners use Honeywell control systems, as do 15 of the world's largest chemical companies and seven of the top ten pulp-and-paper companies.

Figure B-7

Process Controls Market



MARKET OPPORTUNITIES

The need to improve product quality and serve customers better is a major driver in the process controls market. Process controls can result in improved product quality for manufacturers, an increasingly important consideration for developing country manufacturers trying to expand both domestic and export markets. Manufacturers can lower their overall costs by lowering inventory levels, improving their use of installed capacity, instituting quality management.

B.7 INDUSTRIAL MOTORS AND ADJUSTABLE SPEED DRIVES

Motors Motors are commonly used for three general purposes to power pumps fans and compressors for materials processing and for materials handling The three most common types of motors are AC induction motors, AC synchronous motors, and DC motors

Motors commonly account for 65-70% of electricity consumption in industrial facilities They are also used in commercial and institutional facilities A heavily-used industrial motor can consume electricity each year that costs up 50 or 60 times its purchase price in a ten year operating period Since the majority of motors in process industries operate continuously, energy-efficient motors can greatly improve the energy efficiency of an industrial facility It is important to note, however that motor energy consumption is also influenced by other factors such as motor sizing transmission efficiency drive train efficiency motor controls, and operation and maintenance

The efficiency of a motor is defined as the percentage of input power to the motor that is actually converted to useful work output from the motor shaft The efficiency of a motor is improved by reducing losses Intrinsic losses occur in the transformation of electric energy into mechanical energy These losses are comprised of no-load losses and operating losses An energy-efficient motor is typically 2-10% more efficient than a standard motor

All electric motors are fairly efficient converting typically between 75 and 97% of their input power into useful work Hydraulic motors or steam or gasoline engines, by comparison, convert approximately 50% of input power into useful work More efficient motors are predictably more costly than standard ones Thus, the extra expenditure for an efficient motor may not be warranted if the motor is only required for occasional use

Adjustable Speed Drives Many motor-driven processes require some control over the motor's speed, start-up and torque Varying motor speeds are difficult to achieve with AC motors To compensate for the lack of speed variance with an AC motor, many systems use other mechanical devices, such as throttling valves or outlet dampers, to control fluid and air flows while the motor runs at constant speed

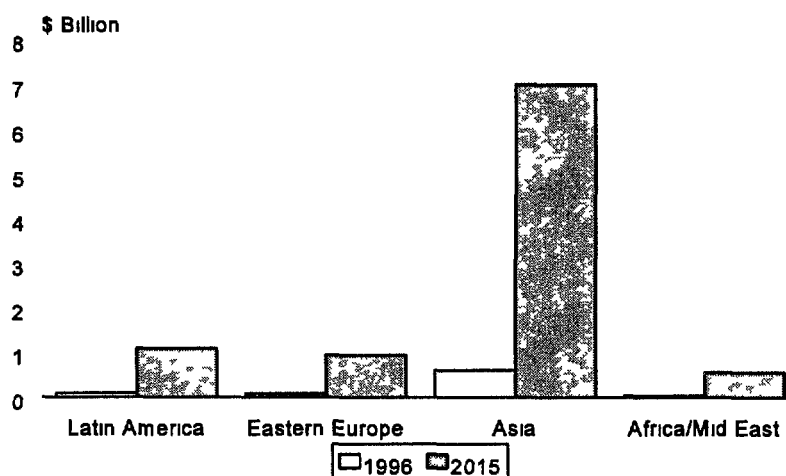
The introduction of adjustable speed drives (ASDs) solved this problem Most electronic ASDs can control a motor over a range of 25% to 100% of its rated speed ASDs have many applications process speed control, energy savings, and soft-starting to reduce wear and tear on motors and other system components

MARKET DEMAND

While the market potential is high, the market share for energy-efficient motors is currently small in most developing countries. In the U.S., most energy-efficient motors are considered a cost-effective investment if the motor is operated more than 200 hours per year. Cost-effectiveness is really a strong function of incremental cost and electricity rates and efficiencies specific to each individual country.

Figure B-8

Energy-Efficient Motors Market



Unfortunately, motor and motor system efficiencies in developing countries are significantly lower than in the industrialized world, for several reasons. First, local manufacturers typically use lower quality materials to make their motors. Second, energy-efficient motors are simply not used because of the poor quality of electric service. If the power voltage drops, motors can stall and even burn out. While this problem affects more than just efficient motors, the high cost of replacement is a deterrent to their use under such conditions. Third, the poor operational and maintenance practices of industries in the developing world leads to further inefficiencies. Motors are typically rewound numerous times during their life. Common rewind techniques and practices in developing countries likely cause significant efficiency losses.

Motor system efficiencies are also lower due to several factors. Equipment is generally older and less efficient than modern equipment. Oversized motors are commonly used. The reasons for this include inaccurate estimates of flow rates and friction, deposit build-up in duct and pipe walls, and the common practice of reusing motors, leading to a mismatch of motor size and load. Finally, common methods of controlling motor speed such as throttling valves and campers instead of ASDs result in further and significant reduction in system efficiency (20 to 25% on average).

Despite these obstacles to the use of efficient motors in developing countries, the size of the market in existence in 1996 was approximately \$812 million. Under the aggressive growth scenario, it is projected to grow to \$9.6 billion by 2015, showing annual growth of 13.9%. Adjustable speed drives were a \$234 million market in 1996, which is expected to grow 16.6% per year to reach \$4.3 billion by 2015, assuming that basic power quality issues can be addressed adequately. Even under the conservative growth scenario, the motor and ASD markets are expected to reach \$2.8 and \$0.7 billion, respectively, by 2015. The largest market for both is expected to remain in Asia, but the Eastern European market for ASDs is also

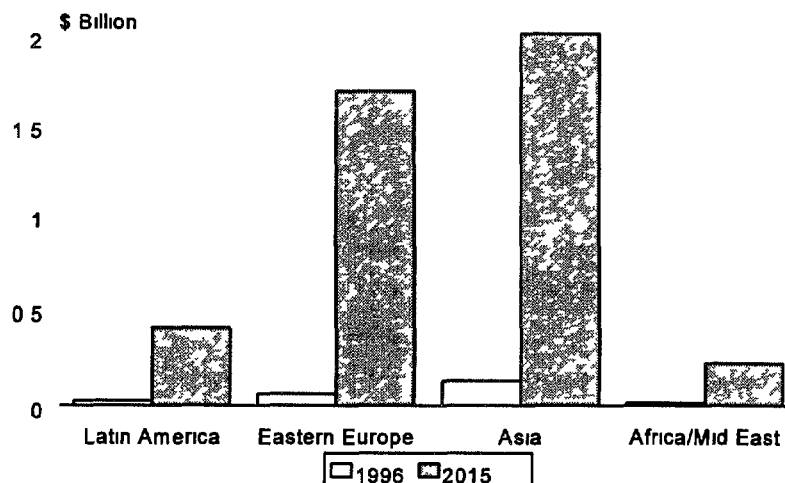
growing rapidly, and will grow even more rapidly once capital constraints ease in the region. Figures B-8 and B-9 give the likely size of the markets in 2015 under the aggressive growth scenario.

Adjustable speed drives are expected to show the most remarkable growth of any technology over the next two decades. This high growth rate is expected because ASDs are a fairly new technology in the market, and serve a much needed purpose of allowing control over a motor's speed, start-

up and torque. Since the use of motors is widespread in industrial, commercial, and residential applications all over the world, ASDs will become increasingly prevalent in conjunction with motor use in certain sectors, where variable load applications are common. The growth and penetration rate will be much higher than that of energy-efficient motors because current penetration is significantly lower than that for motors in developing countries.

Figure B-9

Adjustable Speed Drives Market



COMPETITIVE ASSESSMENT

There are roughly 45 major manufacturers of industrial motors worldwide, though U.S. and European manufacturers dominate the market for energy-efficient motors. Top motor manufacturers internationally include General Electric, Siemens, Toshiba, and Westinghouse. Market leaders in the production of ASDs are ABB and Fuji.

Motor manufacturers attempting to expand their markets in developing countries typically follow one of two approaches. First, they will often establish a joint venture manufacturing facility to produce motors for a local market. ABB followed this approach for the China market. ABB's Chinese joint venture is a market leader for small- and medium-sized motors. Alternatively, companies will establish a local sales office and then import motors to meet demand.

Some manufacturers interviewed for this report claimed that energy efficiency is a marketing tool applicable only in North America. Motors typically are not marketed in developing countries on the basis of energy efficiency (though this practice is emerging in some markets such as Mexico and Indonesia because of Government efforts to educate and offer incentives). To some extent this reflects a lack of

awareness among end-users in developing countries about the benefits of energy efficiency. International motor manufacturers typically sell to distributors. Manufacturers train the distributors to familiarize them with the products and proper operating procedures of energy-efficient motors.

GE Motors and Industrial Systems and Fuji Electric Company, Ltd. formed a holding company for three subsidiary joint ventures (JVs) in February 1996. The JVs are aimed at increasing the penetration of the industrial and commercial drive markets worldwide. Each company holds a 50% stake in the new company. GE Fuji Drives America (GE holds majority interest in this subsidiary) has established headquarters and production facilities in Monterrey, Mexico and will begin operation in 1997; its primary goal is to penetrate the packaged drives market in the Americas. Fuji GE Asia (Fuji holds majority interest) is located in Indonesia, the Philippines, Singapore, Taiwan, and Thailand. GE Motors and Industrial Systems is particularly strong in high-end driven markets where applications call for sophisticated, fully-integrated systems such as those used to control processes in steel mills. Fuji Electric is recognized as a world leader in AC inverter technology for packaged drives which are used for applications such as controlling fans, pumps, and compressors. The partnership will leverage the complementary technical, quality, and market strengths of both companies.

MARKET OPPORTUNITIES AND BARRIERS

Opportunities

Adjustable speed drives, operated with old, inefficient motors, miss efficiency gains. Although the ASD market is projected to grow quickly over the next two decades, if this does not occur in conjunction with a growth in the energy-efficient motors market, some of the benefit of ASD installation will be lost. An opportunity exists to market efficient motors together with ASDs to take advantage of the awareness ASD purchase brings to industrial managers.

Adjustable speed drives provide the ability to efficiently control motor speed. In many processes and HVAC operations, it is essential to control processor air flow. ASDs provide better control and use an estimated 20-25% less energy to do so than conventional methods. Because they are a relatively new technology, ASDs are likely to enjoy a phenomenal growth rate in developing countries where industrial motor use is widespread. Asia will drive much of the demand, due to the sheer size of the market. Eastern Europe will be a major player as well, because of the heavy industrial base in the region. ASDs, because they are electronic, require high quality power. Improvements will need to be made in the quality of power both in the electrical distribution system and within the facility for this growth to occur.

Barriers

The main barriers to energy-efficient motor use are availability and first-cost. In developing countries, where availability of capital is often more constrained than in industrialized countries, the high first-cost of energy-efficient motors relative to their standard efficiency counterparts is often the biggest barrier to the purchase of efficient motors. In many cases, even if a decision were made to purchase an energy-efficient

motor, it would be difficult to obtain due to the relative scarcity of energy-efficient motors on the market in developing countries. Manufacturers have perceived a lack of demand in the past, though this is beginning to change.

Lack of awareness is a significant barrier to the sale of efficient motors. Efficient motor manufacturers are less active in the developing country markets than they are in the industrialized countries. Therefore many industries are unaware of the benefits of efficient motors or of different models of motors available to them. Industries are often equally unaware of the life-cycle costs of motors and the fact that capital costs will be dwarfed over the life of the motor by the cost of energy to run them. This awareness is often masked by low or subsidized energy pricing in developing countries. Additional awareness barriers exist in ministries of industry regarding motor use in their countries. Often data about motor use, not to mention the relationship between motors and energy use, is dispersed or simply unavailable and not compiled.

The prevailing practice of motor rewinding in developing countries prevents penetration of efficient motors. In the developing world, rather than replacing a motor, it is common for a broken motor to be repaired or rewound on-site or in a local shop. While this is also common practice in the U.S. and in some cases economically justified, industry needs to be encouraged to assess the cost-effectiveness of the rewind vs. replace decision. Often the practices used to repair or rewind the motor can seriously degrade a motor's performance and efficiency over time. Economic analysis will often show that for larger motors it can be more cost-effective to replace an inefficient, burned-out motor with an efficient new motor. The USAID Motor Rewind Project in Mexico and the GEF Chilean mining project are two examples of projects that have been developed to overcome this barrier. USAID is also beginning an investigation of the rewind practices in Indonesia in early 1997.

B 8 LIGHTING

There are several types of lamps: incandescent, fluorescent (tubes and compact fluorescent lamps—CFLs), mercury, metal halide, high and low-pressure sodium, and halogen. Fluorescent and incandescent lamps enjoy the most widespread use. Fluorescent lamps give off less heat than incandescent lamps during operation and are much more energy-efficient than incandescent lamps.

The main market segments within the energy-efficient lighting market are the residential, commercial and public sectors. Lighting in industrial applications is generally less energy-consuming than in the other sectors. The incandescent bulb accounts for the majority of lamps used in the residential sector. This is true in both developed and developing countries. According to a 1992 OTA study, incandescent bulbs account for 95% of all residential lighting in Brazil.² There is only limited use of energy-efficient incandescent bulbs. The demand for CFLs in developing countries has increased in recent years, although it is still lower than in industrial nations.

² *Fueling Development*

Fluorescent lighting dominates the commercial market. In commercial buildings, fluorescent tubes are the product of choice. However, as is the case with incandescent bulbs, the most efficient fluorescent bulbs are not used on a widespread basis. T12 tubes are probably the most common product found in the commercial sector of developing countries. T10s are beginning to surface more regularly, but a T8 tube, using 36W versus 40W, could do the same job more efficiently. Cost is one barrier, but the common perception that the smaller T8s are inferior is also a serious deterrent.

The inefficiencies of some types of fluorescent tubes are compounded by the prevalence of magnetic ballasts. According to one U.S. manufacturer, a typical developing country could realize 40% energy savings by replacing the existing magnetic technology with western-quality electronic ballasts.

High intensity discharge lamps (HIDs) are used for the majority of public lighting applications. High- and low-pressure sodium-vapor lamps (sometimes metal halides) are replacing mercury-vapor or incandescent technologies for street lighting throughout the developing world. There have been several successful retrofit projects in Russia, Eastern Europe and Chile.

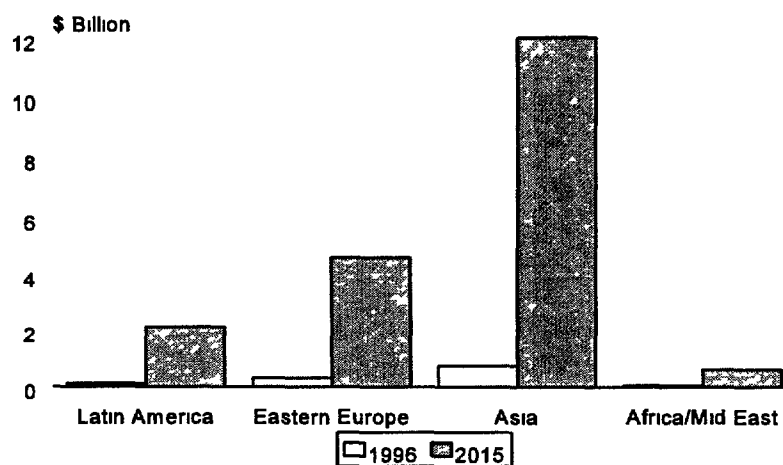
MARKET DEMAND

Energy-efficient lighting is one of the largest market segments in the energy efficiency market. Moreover, this segment is predicted to grow rapidly, attaining a relatively high level of market penetration in most developing country markets in the near future. In 1996 the market for energy-efficient lighting was estimated to be \$1.6 billion with Asia accounting for 64% of the market. Energy-efficient lighting in Asia is currently a \$1 billion market. In 2015, Asia will account for 66% of the developing country market.

This technology market segment will be characterized by rapid growth over the next two decades. Under the aggressive growth scenario, the Latin American market is expected to grow an average of 17% per year, while Asian and Eastern European markets are likely to grow 16% per year. Such high rates of growth will expand the market to be the largest market segment in the overall energy efficiency market, an estimated \$17.7 billion. In

Figure B-10

Energy-Efficient Lighting Market



2015, the five largest single country markets are expected to be Hong Kong, China, Singapore, Taiwan and Poland. Hungary trails these five countries only slightly.

Market penetration rates of energy-efficient lighting vary considerably from country to country, but overall energy-efficient lighting is more widely used than other energy-efficient products. The following examples highlight the regional and country variances in penetration rates.

Asia Market penetration of energy-efficient lighting in Taiwan is higher than in most other developing and emerging market countries. The Taiwanese enjoy higher levels of disposable income than most developing countries, and are thus better able to afford energy-efficient lighting. A more significant factor, however, is the government's aggressive campaign to promote the adoption of energy-efficient lighting. The program began in 1994 and is composed of four major tasks: establishment of lighting efficiency standards, measurement of lighting luminosity, development of key lighting components and lighting application designs, and training of professionals to work in the lighting industry. Early efforts have concentrated on the development of lighting equipment. The program has already resulted in the design of an electronic ballast that needs only 3 to 5 volts of power to light a fluorescent lamp, 90 to 99% of the electricity flowing through the ballast is ultimately used by the lamp. A traditional ballast, by contrast, needs 8 to 13 volts to light a lamp and 40-50% of the electricity is lost. Taiwan's Energy and Resources Laboratories (ERL), a participant in the program, is also in the process of designing a "lighting management system" that will use the electronic ballast, a light controller, and other power saving technologies to achieve an estimated 50 to 80% energy savings. ERL has only recently begun to work on a lighting standard.

Eastern Europe Energy-efficient lighting comprises around 10% of the Eastern European market, this compares to 20-25% penetration rates in western Europe. In Hungary, the market share for energy saving compact light tubes has grown to 10-12% in 1996. GE Tungsram, a Hungarian joint venture manufacturer, intends to expand its market for CFLs by marketing them as a counter weight to the government's increase in energy prices. ES Systems, a Polish lighting manufacturer, has similarly educated Poles as to the benefits of using energy-efficient lighting, with good market success. Poles were previously spending 10% more on lighting than the European average and getting 30% less light, but this situation is improving as a result of the efforts of ES Systems.

Latin America Argentina is the third largest consumer of halogen incandescent lamps in the world. Philips in Chile has set a goal of having 75% of its sales in Chile be from energy-efficient technologies. CFLs are currently selling well in the Chilean market. The marketing for these products has been vigorous, with sales doubling in just two years to 200,000 lamps in 1995. A number of municipalities have replaced their public lighting with metal halide and high and low-pressure sodium lamps. As a result of these efforts, the costs of HID lamps in Chile have dropped 30% since 1991. One proposed project in Buenos Aires has identified 700,000 public lighting fixtures that could be replaced with more efficient lamps. Distributors are starting to use simple payback calculations to demonstrate the economic benefits of buying CFLs.

COMPETITIVE ASSESSMENT

The three largest lighting manufacturers are Osram GmbH, GE Lighting, and Philips Lighting. Each company has a global presence and is expanding its international operations. Osram GmbH, the lighting division of Germany's Siemens, is one of the leading manufacturers of lighting products in Europe, Latin America, Japan, and several Asian countries. In 1993, Osram acquired U.S.-based Sylvania to gain an even stronger presence in the Western Hemisphere. Osram plans to open between eight and ten plants in Asia by 2000 to take advantage of lower production costs. The company completed a new manufacturing plant in China in 1996 and is currently negotiating for a production site in Indonesia. Osram predicts that 15% of its revenue will come from the Asian region in three to five years. The company is also expanding in Eastern Europe and Latin America.

GE Lighting also has offices throughout the world. The company has made a significant investment in the Hungarian lighting firm Tungsram. Tungsram's Nagykanizsa plant is the sole producer of GE's compact fluorescent technology. GE Lighting also has other joint ventures in Asia.

Like the two other major lighting companies, Philips Lighting plans to increase its presence in the fast-growing regions of Asia, Eastern Europe, and Latin America. The president of Philips Lighting has announced that the firm expects to establish five to seven more joint ventures by the year 2000.

Although these companies can claim a significant portion of the global lighting market, they do face stiff local competition in a number of regions, especially Asia and Eastern Europe.

Electronic ballast manufacturers have little experience in developing countries. American manufacturers of electronic ballasts include Magnetek, Advanced Transformer (which has merged with the Philips-owned Electronic Ballast Technology), Valmont Electric, and Etta Industries. These companies continue to concentrate on the U.S. market.

The most common customers for lighting manufacturers are electrical distributors, large stores, or large end-users such as the construction industry, governments, and utilities. The typical residential customer will buy his or her lighting products at retail stores. Only the larger stores, however, buy their merchandise directly from the manufacturer. More commonly, an electrical distributor will act as the intermediary between the lighting company and the retail shop. These distributors also serve the larger consumers—such as construction companies, electrical contractors, the government, and electric utilities—although they may buy directly from the manufacturer. Due to their size and their consolidated nature, these last four players may prove to be the most promising immediate markets for energy-efficient lighting technologies.

MARKET OPPORTUNITIES

Utility DSM lighting programs increase market penetration of energy-efficient products. Utilities have targeted lighting as a significant focus for DSM programs and will most likely continue this trend in the

future creating promising markets for energy-efficient lighting in the process. Between 1992 and 1995 the Mexican utility provided two million CFLs to residential customers in Monterrey and Guadalajara at reduced prices. The expected avoided generation from this program was 196 GWh annually and a capacity savings of 100 MW. In 1996 the Indonesian utility, PLN, launched a DSM program to install CFLs in over 65,000 households. Numerous other countries have also incorporated CFLs into their energy conservation efforts, including Morocco, India, Brazil, and Chile.

Fluorescent tubes have also been targeted. The Thai utility is administering the Commercial Lighting Retrofit Program in which an aggressive campaign has been undertaken to replace the prevalent T12 tubes with the more efficient T8s. The Indonesian lighting program described above also targeted fluorescent tubes in its efforts.

U S Agency for International Development
Bureau for Global Programs, Field Support, and Research
Center for Environment
Office of Energy, Environment, and Technology

The Center for Environment of the Bureau for Global Programs, Field Support, and Research houses the environmental programs of the U S Agency for International Development (USAID). One of five *Centers of Excellence* within the Agency, the Center for Environment, provides field support to U S bilateral assistance efforts, manages global environmental program activities, oversees USAID's environmental research efforts, and is USAID's principal liaison on technical environmental issues to the rest of the U S Government, non-governmental organizations and universities, and other bilateral and multilateral donors.

The Office of Energy, Environment, and Technology is a part of the Center for Environment and helps developing countries and emerging economies find market-oriented solutions to their energy and environment problems. The Office helps set the energy policy direction for the Agency and responds to the short-term needs of USAID's field offices in assisted countries.

A lack of energy is seriously curtailing economic growth in developing countries and countries in transition. Expansion of energy supplies imposes a huge financial burden while increasing environmental threats in these countries. In addition, many countries lack the institutional capability and appropriate technology to operate and manage energy systems efficiently. These factors contribute to the role energy development plays as a leading contributor to global climate change and regional and local environmental problems.

To address these problems, the Office of Energy, Environment, and Technology leverages the financial resources of multilateral development banks, such as The World Bank and the InterAmerican Development Bank, the private sector, and other bilateral donors to increase energy efficiency and expand energy supplies, enhance the role of private power, and implement novel approaches through research and adaptation. These approaches include improving power sector investment planning ("integrated resources planning") and encouraging the application of cleaner technologies that use both conventional fossil fuels and renewable energy sources. The Office's promotion of greater private sector participation in the power sector and a wide-ranging training program also help to build the institutional infrastructure necessary to sustain cost-effective growth.

Further information regarding Center for Environment and Office of Energy, Environment, and Technology activities can be requested by contacting the Office of Energy, Environment, and Technology at the following address:

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