Cleaner Production Eco Labeling Energy Saving Eco Labeling
Design for Environment Extended Producer Responsibility Eco-Efficiency
Green Chemistry Life Cycle Assessment Integrated Water Management
Soft Energy Path Green Productivity Industrial Ecology
Biomass for Environment Circular Economy
Public Product Take Back
Integr Path Circular Economy
Energy omy Eco Labeling
Biomas Assessment
Green biosis Eco-Efficiency
Sound Integrated Water Management

Toward Resource-Efficient Economies in Asia and the Pacific

Waste to Energy Metabolism Pollution Prevention Green Productivity

Eco-Efficiency Green Consumers Pollution Prevention
Biomass Product Take Back Green Chemistry Renewable Energy
Green Consumers Demand-side Management Public Private Partnership
Soft E ath Green Productivity Industrial Ecology Green
Integra ment Soft Energy Path Renewable Energy
Green Produc Demand-side Management

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Waste to Energy Green Consumers Biomass Sound Material Cycle Society
Sound Material Cycle Society Green Building Design Product Stewardship

Toward Resource-Efficient Economies in Asia and the Pacific

REDUCE
REUSE
RECYCLE

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Preface

Patterns of production and consumption in Asian economies are shifting significantly as a result of rapid growth, urbanization, and lifestyle changes. Among others, the levels of consumption of a wide range of resources, including materials, energy, and water, have reached unprecedented levels. This is also driving up greenhouse gas emissions. But Asia's efficiency in using its resources in production and consumption remains low by global standards, leading to high levels of waste per unit of product or service. Many Asian economies are failing to utilize the full value of resources—or mottainai, as the Japanese say.

Such inefficient patterns of resource use must be improved if environmentally sustainable economic growth is to be achieved in the region and the poverty reduction targets set in the Millennium Development Goals are to be met. There is also a direct relationship between higher resource efficiency and a lower carbon footprint. A principal route to sustainable development, therefore, is through reducing the life-cycle based natural capital inputs in the products and services that drive local, national, and global economies. This can only be done by improving resource efficiency—the amount of resources (materials, energy, and water) consumed in producing products or services.

This publication provides guidance to policy makers in the developing countries of Asia and the Pacific on the economic and environmental significance of resource efficiency and options for encouraging efficiency improvements. One of the key messages is that developing countries have the opportunity to leapfrog over conventional or outmoded technologies or production and consumption patterns by pursuing new options that simultaneously offer economic and resource efficiency gains along with environmental benefits.

The analysis presented is part of a wider effort initiated by the Asian Development Bank to facilitate economically efficient and environmentally beneficial investment in Asia and the Pacific and to support the Reduce, Reuse, and Recycle (3R) Initiative of the G8 nations as adopted at the 2004 G8 meeting and launched at a ministerial conference in Tokyo in 2005. Many international organizations and over 30 countries have agreed on the importance of the 3Rs in the context of sustainable development and have been supporting wider application of the 3R approach.

One focus of the 3R Initiative is on the international flow of materials. While other related efforts have centered on improving resource efficiency in production or in consumption, the 3R Initiative opened discussion on existing and future cross-border movement of secondary materials on a global scale.

The economies of Asia have already entered a period of rapidly increasing resource constraints and transition as they seek to maintain their economic growth without generating local environmental costs or unduly contributing to global environmental problems, such as climate change. National and local governments, the private sector, the academic community, nongovernment organizations and international organizations must all play a part in this transition. Measures are needed to ensure that rapid economic expansion can continue even as the proportions of energy and raw materials per unit of economic output decrease.

By providing a review of these issues and laying out a range of options for pursuing more resource-efficient economic growth, this report should assist decision makers in identifying strategies, policies and priorities for associated public and private sector investments to meet these objectives. While the paper centers on Asian and Pacific experience and options, the global consequences of resource use inefficiencies make this a topic of wide interest even outside of the region.

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ADB received valuable inputs from those drawn from government agencies, the academic community, nongovernment organizations, private sector entities, and development agencies at subregional workshops on this topic held in South Asia (Kathmandu, August 2006) and Southeast Asia (Manila, February 2007). These workshops were jointly organized by ADB, the United Nations Centre for Regional Development, the United Nations Environment Programme, the Institute for Global Environmental Strategies (IGES), and other international or regional entities cooperating through the G8 3R Initiative.

This publication would not have been completed without the persistent and able efforts of Richard Stevenson and Jeffrey Bowyer, who served as consultants to ADB in preparing major sections of the report and coordinating the inputs of other contributors. Our gratitude also goes to the resource persons who provided specific contributions—Ernest Lowe of Indigo Development on industrial ecology, Michikazu Kojima of the Japan External Trade Organization on trade issues, Amit Jain of International Resources Group on electronic waste, and Prof. C. Visvanathan of the Asian Institute of Technology on solid waste management.

The report was prepared in close collaboration with IGES, represented by Yasuhiko Hotta, Policy Analyst, Waste and Resources Project. Other researchers from IGES who contributed to the report include Chika Aoki, Kentaro Ofuji, Saori Nakanishi, Oyuna Tsydenova, Shashi Kad, Maricor Muzones, Yatsuka Kataoka, Kyoko Matsumoto, and Tetsuo Kuyama.

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Prologue: Report Structure and Key Messages

Both the public and governments across Asia and the Pacific are now giving very high attention to the environmental consequences of rapid economic growth and how to balance concern for environmental quality with the desire to continue the fast pace of development. Most of this report focuses on the vital role that governments, particularly national governments, can play in moving Asian economies toward greater resource efficiency as an important part of the answer to this question. While many of the specific strategies described in the report are not new, the unique contribution of the report is that it offers both a strong context for understanding the importance of attention to resource efficiency as a measure of how a country, sector or even a product is doing from the standpoint of balancing environment and economic factors as well as providing a range of policies, cases, and tools tailored to the Asian context.

Chapter 1 of the report explains the concept of resource efficiency and the reasons why this concept is essential to the new mix of clean, green, and economically efficient policies and programs for achieving environmentally sustainable economic growth. One of the central points is that any improvement in resource efficiency—whether in production or consumption—will almost always result as well in reduced greenhouse gas emissions. There is thus a direct link between resource efficiency improvements and efforts to mitigate climate change. But the report also shows that improving resource efficiency produces not only environmental gains but also can generate significant economic, financial, and social benefits.

Chapter 2 discusses the current inefficient use of materials, energy, and water in Asia and the Pacific, which is, nevertheless, associated with rapid economic growth. The inefficiencies are tied to the continued use of older manufacturing technologies and management practices coupled with patterns of consumption that seek to emulate those of Europe and North America. It also includes a discussion of the economic and environmental constraints associated with inefficient resource use.

Chapter 3 begins an analysis that stretches through Chapter 10 of the important roles that governments must play in efforts to improve resource efficiency. It stresses the need for integration and coordination across resource sectors and emphasizes the need for a transition to a future use of materials, energy, water, and land through strategic planning and in a more integrated manner. This integration is discussed across its spatial, temporal, and organizational dimensions.

Chapter 4 lies at the core of the report, examining the role that national governments can play in moving their economies toward greater resource efficiency and promoting the environmental enterprises needed to deliver it. It focuses on policy responses to the inefficient use of materials, energy, and water. While the management of wastes has traditionally addressed only material wastes, this report considers energy, water, and land as important resources, because their efficient use is vital to achieving a more sustainable pattern of development.

The last section of the chapter discusses four kinds of commonly applied policy instruments: regulatory, economic or market-based, informational, and voluntary.

Chapter 5 discusses compliance and enforcement issues, a weak link in the policy chain of many Asian countries' approaches to these problems. This chapter stresses the need for realistic institutional approaches to policy implementation, the absence of which will doom even the most progressive legislative reforms to failure.

Chapter 6 focuses on the critical role of local authorities in promoting improved resource efficiency. Local authorities are in a good position to influence the consumption habits that lead to high resource use. Community-based organizations and nongovernment organizations also play an essential role in local programs, especially in the areas of public awareness and education.

Chapter 7 discusses the importance of promoting investments in resource-efficient infrastructure for developing countries, given that infrastructure investments can establish a country's pattern of resource use for decades to come. This chapter highlights a key message of the report—that developing nations can leapfrog ahead to new technologies and economically and environmentally efficient solutions to the challenge of balancing rapid economic growth with environmental sustainability. Examples are provided in the areas of decentralized wastewater systems, resource recovery and recycling systems, and green buildings.

Chapter 8 looks at the role of governments in promoting greener enterprise development and new technologies, including research and development, technology transfer, and technology evaluation. It also looks at some major environmental technologies and services that investors may consider in searching for more resource efficient options.

Chapter 9 turns to actions that governments can take to improve support to industry, including public industrial facility managers in the region. These actions can help managers understand the real costs of waste and the benefits they can gain from adopting new practices and technologies.

Chapter 10 looks at regional aspects of resource efficiency, including the promotion of safe trade in secondary materials. As discussed in this chapter, transboundary trade in recyclable wastes can either complement waste minimization in the region or it can significantly increase environmental pollution and human health risk, depending on how it is conducted.

A final chapter highlights two fundamental propositions that emerge from the report. The first is that the economies of the region cannot continue long to support the very high demand for renewable and nonrenewable resources without significant negative consequences (e.g., excessive greenhouse gas emissions, higher international and domestic commodity prices, natural resource degradation, falling environmental quality) if current resource inefficient development patterns persist.

Second, governments around the region have the ability to follow an alternative development path that can not only help avoid such impacts but can also take advantage of enormous opportunities to invest wisely in infrastructure and institutions for their future. This can be done in ways that will simultaneously strengthen competitive advantage, generate jobs, and provide for a clean and productive environment.

Abbreviations

3Rs	–	reduce, reuse, recycle
3RKH	–	3R Knowledge Hub
ADB	–	Asian Development Bank
AFP	–	Agence France-Presse
AECEN	–	Asian Environmental Compliance and Enforcement Network
AIT	–	Asian Institute of Technology
ASEAN	–	Association of Southeast Asian Nations
BMRA	–	British Metals Recycling Association
CPCB	–	Central Pollution Control Board
CDM	–	Clean Development Mechanism
C&D	–	construction and demolition
DENR	–	Department of Environment and Natural Resources (Philippines)
CER	–	certified emissions reduction
DfE	–	design for environment
DIW	–	Department of Industrial Works (Thailand)
DSM	–	demand-side management
ECCJ	–	Energy Center Conservation of Japan
ECPF	–	Energy Conservation and Promotion Fund
EE	–	energy efficiency
EIP	–	eco-industrial park
EMS	–	environmental management system
EPR	–	extended producer responsibility
ESCO	–	energy service company
EU	–	European Union
e-waste	–	electronic waste
G8	–	Group of Eight
GDP	–	gross domestic product
GEF	–	Global Environment Facility
GHG	–	greenhouse gas
GNP	–	gross national product
GSC	–	greening the supply chain
GTZ	–	German Agency for Technical Cooperation
HS	–	harmonized commodity description and coding system
IE	–	industrial ecology
IEEFP	–	International Energy Efficiency Financing Protocol
IGES	–	Institute for Global Environmental Strategies
ISW	–	industrial solid waste
IWMI	–	International Water Management Institute
IWRM	–	integrated water resources management
JAMP	–	Japan Article Management Promotion Consortium
JBRC	–	Japan Battery Recycle Center
Lao PDR	–	Lao People's Democratic Republic
LFG	–	landfill gas
LGU	–	local government unit
LCA	–	life-cycle assessment

LEED	–	Leadership in Energy and Environmental Design
MDG	–	Millennium Development Goal
MEP	–	minimum energy performance standard
METI	–	Ministry of Economics, Trade and Industry (Japan)
MIEEP	–	Malaysian Industrial Energy Efficiency Improvement
MOEF	–	Ministry of Environment and Forests (India)
MSW	–	municipal solid waste
NGO	–	nongovernment organization
NRW	–	nonrevenue water
OECD	–	Organisation for Economic Co-operation and Development
PC	–	personal computer
PCB	–	Pollution Control Board
PCD	–	Pollution Control Department (Thailand)
PEP	–	Philippine Environmental Partnership Program
PRC	–	People's Republic of China
PRO	–	producer responsibility organizations
PUB	–	Public Utilities Board (Singapore)
RDF	–	refuse-derived fuel
R&D	–	research and development
REACH	–	registration, evaluation, authorization, and restriction of chemical substances
RoHS	–	restrictions on hazardous substances
RSCO	–	resource service company
SMEs	–	small and medium-sized enterprises
TERI	–	The Energy and Resources Institute (India)
UN	–	United Nations
UNDP	–	United Nations Development Programme
UNEP	–	United Nations Environment Programme
UNESCAP	–	United Nations Economic and Social Commission for Asia and the Pacific
US	–	United States
WEEE	–	waste electrical and electronic equipment
WHO	–	World Health Organization
WSSD	–	World Summit on Sustainable Development
WTE	–	waste to energy

Chapter 1. Resource Efficiency: What is It and Why is It Important?

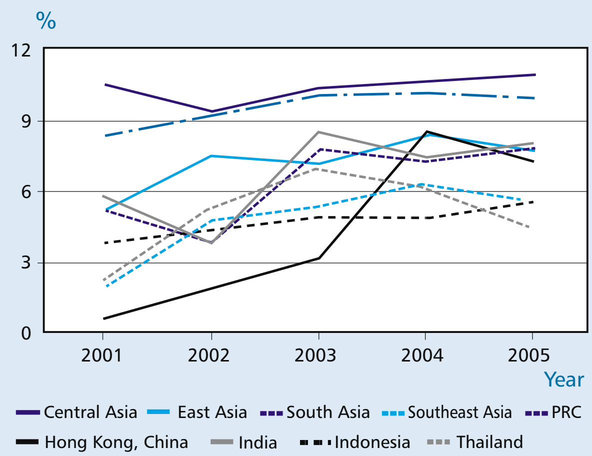
Production and consumption in Asia and the Pacific are outpacing the renewal capacity of natural resources and the capacity of local governments to manage wastes. New approaches to reducing, reusing, and recycling wastes are essential to the sustainable future of Asian and Pacific economies.

The Environmental Challenges of Economic Growth and Urbanization in Asia

Asia is now the most economically dynamic region in the world. Sustained economic growth, especially in the People's Republic of China (PRC), India, and parts of Southeast Asia, has been truly impressive over the past 40 years. In 1960, the 10 biggest Asian economies accounted for just over 12% of world gross domestic product (GDP). Today, that share has doubled to about 25%.[1] Developing Asia is expected to continue its upward economic trend, with an 8.3% growth rate projected for 2007 (Figure 1.1).[2] GDP per capita is also growing at a high level (Figure 1.2). This economic progress has helped raise tens of millions of people out of poverty.

Much of this economic expansion has been associated with rapid urbanization (Figure 1.3). Within the next 15–20 years, at least 50% of Asian populations will be living in huge urban sprawls that also contain some of the world's most important industrial facilities, such as in the Pearl River delta

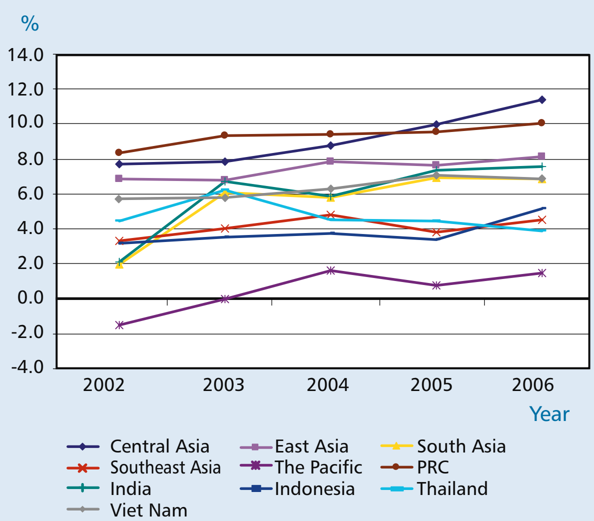
Figure 1.1: Growth Rate of GDP in Selected Countries in Asia



GDP = gross domestic product, PRC = People's Republic of China, % = percent.

Source: ADB. 2006. *Asian Development Outlook 2006*. Manila.

Figure 1.2: Growth Rate of GDP Per Capita in Asia



GDP = gross domestic product, PRC = People's Republic of China, % = percent.

Source: ADB. 2007. *Asian Development Outlook 2007*. Manila.

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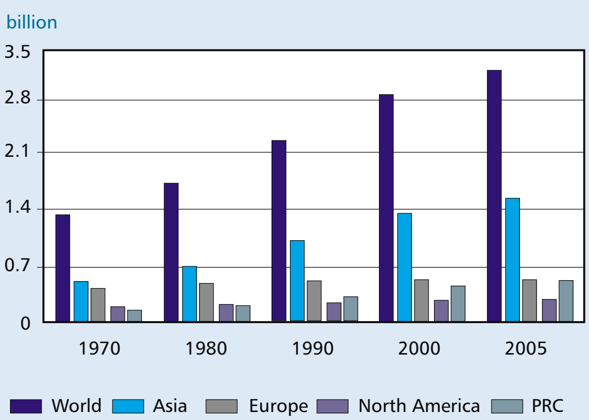
1 Krueger, Anne. 2005, 14 December. Still Achieving, *Still Pursuing: The Global Consequences of Asian Growth.* Remarks by First Deputy Managing Director, International Monetary Fund to the Asia Society, Hong Kong, China. Available: http://www.imf.org/external/np/speeches/2005/121405a.htm

2 Asian Development Bank (ADB). 2007. *Asian Development Outlook 2007 Update*. Manila.

in the PRC.[3] About 1.56 billion people live in the region's urban areas, projected to grow to 2.21 billion by 2020.[4] Urbanization is bringing enormous economic and social benefits to most Asian countries. Cities form the main link between national economies and the global economy, and as engines of job creation, cities are an important basis for poverty reduction.

Despite bringing many benefits, economic growth and rapid urbanization have not come without a price. These trends have triggered a decline in Asia's natural capital—shrinking forests, declining biodiversity, disappearing water sources, and barren lands. At the same time, much of the region's urbanization is occurring with little or no environmental controls. The result is uncontrolled urban sprawl, fetid slums, unprecedented levels of air, water, and land pollution, and inadequate urban services (e.g., water supply, sanitation, wastewater treatment and sewerage systems, drainage, and solid waste management). These deficiencies inhibit economic growth, place further stress on natural systems, and damage public health and the investment climate. They severely constrain the potential for urban areas to contribute fully to economic growth.

Figure 1.3: Asia's Growing Urban Population



PRC = People's Republic of China.
Source: United Nations. 2005. *World Population Prospects. The 2004 Revisions Population Database.* New York.

Source: AFP

While the management of urban areas is getting increased attention, agriculture for food, fiber, and energy production remains the largest single user of energy, water, materials, and land resources, and is the largest source of waste. Conventional, petrochemical farming has serious liabilities. The green revolution increased energy flow to agriculture to 50 times the energy input of traditional agriculture. Agriculture is also a major consumer of water resources in most countries, much of it consumed inefficiently and with free or subsidized cost to the user.

While developing countries cannot be denied the chance to share in the planet's wealth, it is important to acknowledge that negative environmental effects will continue if they continue to follow current development patterns. For example, the PRC's rapid economic growth demands major supplies of all basic industrial commodities in competition with other nations, and its contribution to greenhouse gases (GHGs) is rising rapidly. Based on ambitious development targets set by the Government, a population of 1.8 billion will likely reach a per-capita GDP of $4,000 per year by 2050, five times the current level. [5] This growth will demand a tremendous increase in production and will multiply pressure on natural resources and the environment unless the development path becomes more environmentally benign.

3 Boyd, Alan. 2002, 26 November. Environmental Cost of Asia's Development. Asia Times Online. Available: http://www.atimes.com/atimes/Asian_Economy/DK26Dk01.html

4 Brockerhoff, Martin. 1999. Urban Growth in Developing Countries: A Review of Projections and Predictions. *Population Council Paper* No. 131. Available: http://www.popcouncil.org/pdfs/wp/ See http://esa.un.org/unpp/ for the latest projections by the UN Population Division.

5 Indigo Development. 2005 July. *China Seeks to Develop a "Circular Economy"* (CE). Available: http://www.indigodev.com/Circular1.html

Given the present trends in consumption and the growing world population, it is questionable whether our globe can continue to withstand growing levels of pollution and resource extraction without major adverse consequences in the near future. Human populations cannot expand indefinitely with everyone expecting to live at the current levels of consumption and production in developed countries. Adjustments are needed in both the developed and developing worlds.

The international concern over global climate change is intensifying attention to these issues. The impacts of climate change may be disastrous to developing Asian countries, many of which will be ill-equipped to deal with the resulting effects on agricultural output, labor productivity, health, and internal displacement. Another worrying development throughout the region is the inefficient use of water, leading to such adverse impacts as overpumping of aquifers. As water tables fall and surface water variability increases, harvest cutbacks could occur simultaneously in many countries, creating potentially unmanageable food scarcity.[6]

If the grim climate change scenarios being forecast by some experts come to pass, the hardest hit will undoubtedly be the poor. They are more directly exposed to pollution and the extremes of nature brought on by climate change and have a greater dependence on natural resources, such as crops, livestock, and biomass fuels.

Opinions differ on the resilience of social, technological, and market systems to the environmental problems we face today. Some contend that the Earth cannot continue to support demand for oil and other exhaustible resources for long, given current development patterns, without enormous price increases and severe resource degradation. Others claim that the Earth can amply provide for society's needs for the indefinite future with the help of markets, appropriate public policies, and new technologies.

This report explores the basis for both viewpoints. The authors believe that if humanity does not change its current production and consumption patterns, it will eventually be shocked into adjustments through the blunt instruments of economic recession, environmental disasters, or increased civil strife (or all three simultaneously). This report, while presenting these global and regional realities and problems, also offers hope for the future based on positive changes already apparent.

Most of the paper is focused on identifying an alternative path that could avoid economic and environmental decline. This path involves countries breaking away from current patterns of economic growth and embracing more resource-efficient norms. By taking this path, countries can reduce mounting levels of wastes and pollution along with associated environmental and economic impacts and costs. The choice should be clear—make the necessary sacrifices now or pay dearly later. This must be done with the understanding that only by realistically confronting the challenges of the present and thinking systematically about consequences and interactions can a sound blueprint for change be developed and implemented.

Resource Efficiency, Waste, and Related Concepts

Before embarking on a review of resource efficiency in the region, it is important to define some concepts. In this report, we define resource efficiency as the amount of resources (materials, energy, and water) consumed in producing a unit of product or services. Practicing resource efficiency involves using smaller amounts of physical resources and generating less waste to produce the same product or service. It also encourages patterns of consumption that use fewer resources through the design of products and services and their delivery to consumers. This requires a perspective and a decision-making process that simultaneously considers both economic value and environmental sustainability.

Renewal and conservation of natural capital form the foundation for achieving sustainable resource efficiency. Natural capital assets are embodied in land (forests, farms, aquifers, grasslands, urban space); aquatic systems (rivers, lakes, wetlands, coastal and marine ecosystems); the atmosphere; and the dynamic cycles of nature. The route to sustainable development is, in part, through minimizing net

[6] Rizvi, Haider. 2007, 28 July. OneWorld.net. *Washington Pressed to Lead as Water Tables Fall*. Available:http://www.iwmi.cgiar.org/Press/coverage/pdf/Washington%20Pressed%20to%20Lead%20as%20Water%20Tabl.pdf

natural capital inputs throughout the entire life cycle of the products and services that drive local, national, and global economies.

Every product has several stages in its life cycle, including

- extraction of natural resources,
- processing of resources,
- design of products and selection of inputs,
- production of goods or services,
- distribution,
- consumption,
- reuse of wastes from production or consumption,
- recycling of wastes from consumption or production, and
- disposal of residual wastes.

Every one of these stages can create waste and environmental residuals that can become chemical or organic pollutants and can contribute to climate change, among other impacts (Figure 1.4). Pollutants include carbon monoxide, lead, nitrogen dioxide, particulate matter, sulfur dioxide, carbon dioxide, hazardous chemicals, and many more.

Figure 1.4: Life Cycle of a Product

Source: Modified from www.environment.gov.au/settlements/industry/corporate/eecp/publications/shop.html

Life-Cycle Assessment

Life-cycle assessment (LCA) looks at environmental impacts across the full product life cycle, from the mining or extraction of raw materials used in its production and distribution, to its use, possible reuse or recycling, and eventual disposal. An LCA can quantify how much energy and raw materials are used and how much solid, liquid, and gaseous wastes are generated at each stage of the product's life. Research is currently being devoted to developing and applying models for predicting the service life and life-cycle costs of reinforced concrete structures, including developing methods for evaluating the durability of high performance concrete, and evaluating repair systems for deteriorated reinforced concrete structures. The International Organization for Standardization (ISO)14040 series of environmental management guidelines provides a consistent methodological approach commonly used since 1997.

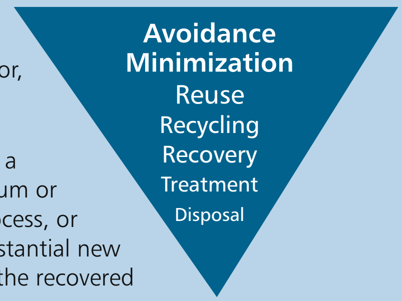
Using LCA, the true environmental effects of our consumption choices become clearer. Many consumer electronics, for example, are manufactured efficiently but are difficult to dispose of in an environmentally sound manner at the end of their useful lives. Most electronics manufacturers still use hazardous materials in their products and do not design their products for easy disassembly, and most government policies fail to hold manufacturers responsible for end-of-life management of their products. Thus, manufacturers continue to externalize these costs by allowing their products to go to landfills or poorly regulated waste-recovery schemes. This status quo—where end-of-life costs are not incorporated into the upfront price of new products—ensures that electronic waste (or e-waste) will only have positive value in poor countries that have low labor costs and weak environmental and health standards.

Even products that are considered environmentally friendly look less desirable when their impacts are assessed over their life cycle. For instance, hybrid vehicles may not always offer the net energy savings that many environment-conscious drivers would like to believe, largely because their batteries contain heavy metals, such as cadmium and nickel (and they still run on fossil fuels). Nickel must be mined (sometimes at significant environmental cost), transported, refined, and transported again before

Box 1.1: The 3R Hierarchy

Reducing wastes by all feasible means is the first in a hierarchy of priorities. From either a business bottom line or a national economy perspective, it costs much less to make processes more efficient and prevent wastes from occurring than to later consume more energy and materials to capture the waste streams and then to reuse, recycle, or dispose of them.

Reusing wastes is the next level of priority. It involves using resources in their existing forms (e.g., glass bottles, wood scraps, chemical process by-products, secondary water, or surplus energy) so that minimal additional labor, material, water, and energy are required to achieve beneficial use.



Recycling wastes is the third priority. It involves transforming resources into a form that can be used as an input to a new process (e.g., recovering aluminum or plastic from drink containers, reprocessing a by-product from a chemical process, or processing wastewater for secondary use). This third level often requires substantial new inputs of materials, energy, and water so that the net gain is limited, unless the recovered resource has a relatively high value.

Source: ADB.

the battery is produced. The environmental costs associated with these activities must be compared against the energy savings that accrue from increased fuel efficiency to assess the true environmental benefits of driving these vehicles.

Applying LCA across an entire economy requires an understanding of the consumption patterns that have the greatest life-cycle environmental impacts over the long term. For instance, investments in large infrastructure or building projects lock in environmental and economic impacts for decades. Therefore, resource-efficient, high performance, and integrated designs need to be promoted over conventional designs.

It should be noted that there are some limitations to broadly applying LCA. For instance, the LCA method used is not suitable for expressing the most important environmental impacts caused by the use of resources, such as loss of biodiversity and the environmental impacts of agriculture. Another unsolved problem is how to deal with imports and exports in determining life-cycle impacts.

The 3Rs

The 3Rs—**reducing** resources and wastes generated throughout the life cycle of products and services, **reusing** products and waste materials (including production by-products) independently or as inputs to other production processes, and **recycling** wastes into a form suitable for use as an input to production—lie at the heart of any effort to achieve resource efficiency (Box 1.1).

LCA allows to compare the benefits of recycling resources with extraction and production of materials from virgin resources. For example, the energy used in recycling aluminum is only 5% of that used in aluminum production from bauxite, and recycling of copper uses only 15% of the energy required for production from copper ore.[7] The British Metals Recycling Association (BMRA) claims that using recycled steel to make new steel can lead to reductions of 86% in air pollution, 40% in water use, and 76% in water pollution.[8] In addition, some estimates show that a ton of paper from recycled fibers instead of from virgin pulp can save about 26,500 liters of water, 4,000 kilowatt-hours (KWh) of electricity, and about 27 kilograms (kg) of air pollutants.[9]

7 International Aluminum Institute's Webpage. Available: http://www.world-aluminium.org/production/recycling/index.html

8 British Metals Recycling Association website. Available: http://www.recyclemetals.org/whatis.php

9 Estimate of United States.

LCA can also reveal the benefits of promoting reuse and recycling over landfilling. As discussed in Box 1.2, there is an opportunity to capture much higher benefits from biomass, which accounts for a major share of the waste stream in many Asian and Pacific countries.

Thinking about Waste: From Loss to Gain

Part of the transition to more resource-efficient societies will entail a shift in thinking about the definition of waste. Waste is traditionally thought of as having no value. Moreover, waste is widely assumed to be inevitable. This leads to economic and

Box 1.2: Life-Cycle Decision Making and Biomass

A major share of the Asia-Pacific countries' waste stream is biomass, most of it discarded in landfills. There is an opportunity to capture much higher benefits. The use of biomass at the end of production and consumption cycles is the last point for increasing the efficiency of its use. Life-cycle analysis suggests additional points of intervention along the metabolic flow to improve materials management by optimizing the utilization of resources and minimizing the environmental impacts of using them.

Actors at any point along the life cycle of products make decisions that can increase efficiency and reduce impacts. The sources, materials, routes, options for processing, markets, and agencies responsible for biomass are highly diverse. Many biomass processing companies use either virgin or discarded materials, which adds another level of complexity. Therefore, the effective use of biomass requires a framework for more integrated materials management. Each decision maker needs to see the whole system and know how to make choices that optimize the use of this resource stream and minimize the environmental impacts of its use.

This is illustrated by reviewing some key factors at different points of intervention.

- **Extraction of raw materials.** Policies should encourage farm and forestry operations to perceive all material outputs as products and to maintain the value of what were formerly considered wastes. Practices to encourage include minimizing wastes in harvesting, balancing the sale of by-products with on-site use for soil regeneration, separating by-products in terms of requirements of the biomass processors; and following the basic practices of cleaner production for energy efficiency and pollution prevention.
- **Processing of materials.** Similar policies and practices are needed for food, fiber, and wood-processing companies.
- **Selection of materials.** Policy changes are required to eliminate subsidies that favor virgin over-recycled materials and fossil energy over renewable energy.
- **Transportation of materials and products.** The relatively low economic value of many biomass discards makes the efficiency of transportation and distance to market crucial to the financial feasibility of their use.
- **Using materials to create products and services.** Policies governing food-processing plants, wood mills, restaurants, and other processors are similar to those for extraction, but specific to these industries. Product and process design guidelines help assure low waste and ease of recycling or reusing of products.
- **Using products and services.** Policies for consumers in all sectors support awareness building, and encourage consumer practices of waste minimization and preservation of value of discards.
- **Recovery or disposal of used products and material.** Biomass is a major part of the present waste stream and using it has major implications for the public sector. Policy governing these resource flows needs to account for the reductions in public investment and other public benefits achieved by this transition. (These include avoided cost of new landfills and public collection, and the health and environmental benefits.) These savings can be used to support the creation of a niche collection infrastructure, the startup of new materials processing companies and energy generators, research and development, and the coordination required for allocation of resources.

Source: Lowe, Ernest A. 2007. Integrated Regional Action Planning of Biomass Utilization. Presentation to California Association of Resource Conservation and Development Councils Fall Conference, 25 April 2007. Indigo Development. http://www.indigodev.com/RCDC_biomass_Lowe_apr25.ppt

Box 1.3: Why Do We Waste?

Most societies have historically believed that the world has unlimited resources and that things can be thrown away without negative consequences. Even though we increasingly know better, we still largely act as if this were true. Our prevailing economic system does not provide adequate incentives for conservation and efficient resource allocation. Societies everywhere—including their governments, managers, and consumers—still act as though resources are to be used and then disposed of, and, by doing so, fail to take advantage of the many benefits of increased resource efficiency.

Governments concerned about making local industries more competitive often subsidize key inputs such as water, electricity, fuel, and food commodities, thereby creating artificially low prices. Moreover, prices of most goods and services do not reflect the full environmental and social costs of resource extraction, processing, production, and consumption, or the full costs of waste management. As a result, resources are routinely overused, creating both pollution and shortages. The overall effect is to encourage greater resource consumption than is economically or even financially efficient and to discourage development and diffusion of more resource-efficient and cleaner technologies and policies.

Most managers fail to understand the extent of waste in their systems or its cost to the bottom line. One reason is weak measurement of input and waste streams. Another is that decision makers lack adequate information on the technological and operational options available to them. Waste remains invisible in accounting systems and organizational reward systems. The costs of producing and disposing of waste are buried in a company's or agency's overhead and are not reflected as line items in management or cost accounting. National accounting systems also misrepresent the benefits and costs of resource use efficiency. The costs of services for collecting, transporting, and disposing of wastes, and for storing, treating, and disposing of hazardous materials actually adds to gross domestic product.

Many consumers do not fully appreciate their role in the inefficiency equation. Wasteful practices are still the norm. For instance, consumers are increasingly using and discarding voluminous materials, such as food containers and plastic bags that are frequently dumped in waterways and clog sewerage systems. In addition, rapidly increasing consumption in both developing and developed countries is driving up resource utilization beyond the rate of efficiency improvements.

Quantities of waste that must be managed for final disposal will continue to grow until production processes and consumption patterns become more resource efficient. Until then, the enormous costs of wasteful practices should serve as a strong motivation to pursue resource efficiency of production and consumption and to search every avenue to reduce, reuse, and recycle "wastes."

Source: ADB.

management practices that actually tend to promote the generation of waste (Box 1.3).

In a resource-efficient economy and society, the term "waste" would refer only to those residual materials that have absolutely no potential to be used and, therefore, have no economic value. Under this definition, traditionally "valueless" streams of waste can be considered resources for a new tier of the economy. They can be recovered (or prevented from being lost) through greater efficiency and management at every stage of production and consumption. Even many hazardous or toxic materials may be recycled or re-refined for reuse. For instance, the Recycle Engineering Co. refinery in Thailand re-refines cleaning solvents, returning them to manufacturers at near virgin quality.[10] Businesses devoted to resource recovery recommend phasing out the word "waste" altogether from the lexicon of bureaucracies and supporting legislation. It is a word that hides the value of the by-products of industry and commerce.

Source: AFP.

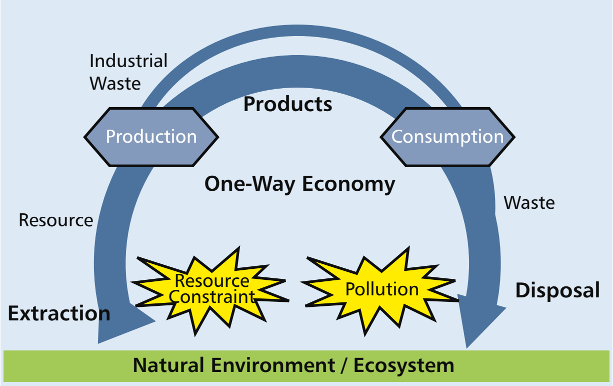
[10] Lowe, Ernest A. 2001. *Eco-Industrial Handbook for Asian Developing Countries*. Manila: ADB. Available: www.indigodev.com/Handbook.html

This shift in thinking about waste is evident in a number of emerging applications of the life-cycle approach. These include policies to apply the 3Rs, extended producer responsibility (EPR), and design for environment. They also include innovative market-based mechanisms to encourage environmentally beneficial behavior, such as the clean development mechanism (CDM) and demand-side management (DSM).

Figures1.5–1.7 illustrate the changes in the flow of resources and waste as different resource-saving measures are applied to an economy, from resource extraction and production to consumption and final disposal.

Figure 1.5 shows a "one-way" economy in which little effort is made either to reduce the amount of materials consumed in production (and thereby the wastes produced) or to reuse or recycle those wastes. Both the materials embodied in the production and the wastes produced in the production make a largely one-way trip from extraction to landfill, with that portion of the materials captured in the products only being delayed in completing the journey.

Figure 1.5: The One-Way Economy



Source: ADB.

This was the basic model followed when many developed countries were mainly focused on end-of pipe disposal of wastes, which was the case until the 1970s. In most industries, little attention was paid to how wastes were produced or what could be done to reduce their volume or toxicity. Instead, environmental policy and regulation focused on avoiding pollution at the end of the pipe. Environmental management generally had a narrow focus on operating pollution control equipment and basic housekeeping of the production process to stop spills and leaking pipes. It should be noted that a one-way economy has never fully existed, especially in the developing world, because of the very effective informal waste management sector, which has always recycled portions of material wastes. Nevertheless, the economies of many developing countries in Asia are still largely dominated by a linear and wasteful flow of resources.

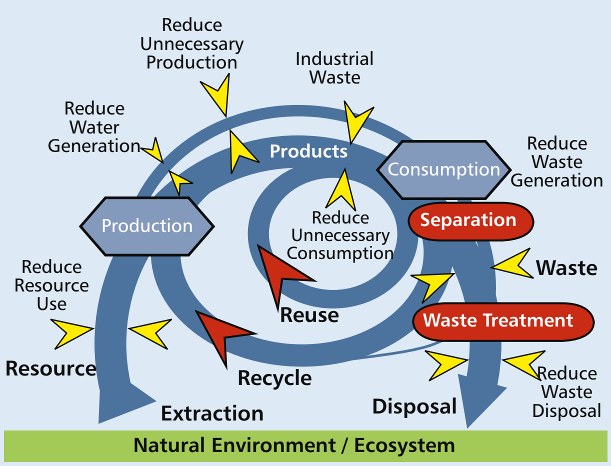
Over time, particularly as economies and production technologies advance and as the middle class increasingly makes its voice heard, pressure builds to implement more comprehensive approaches to reducing environmental impacts. This typically results in legislative, social, and market pressures on industry to exercise greater responsibility for its environmental performance. As these pressures mount, programs focused on end-of-pipe treatment and disposal evolve into those stressing greater efficiency in the production process, through cleaner production or eco-efficiency programs.

At this stage, scientists, engineers, industrial managers, and many others recognize that true long-term sustainability of economic systems requires that societies learn to break their dependence on single use throughput of natural resources and growing production of wastes. There is a shift from an after-the-event, "react and treat" approach to a forward-looking, "anticipate and prevent" philosophy, as advocated in cleaner production and eco-efficiency programs.[11] Where end-of-pipe waste disposal is a sunk cost with no financial return (other than avoidance of fines), improvement of the production process brings financial benefits to the producer as well as improvement of the quality of the products. Building-in environmental considerations early in the process, before capital equipment is purchased and distribution channels are developed, is arguably the least expensive time to make proactive design decisions that can, in turn, influence the entire life-cycle chain.

Design for environment (DfE), also known as green design and ecodesign, is part of this movement. It involves reducing environmental impact and resource consumption by improving the design of a product. The major characteristic that distinguishes DfE from more traditional

[11] United Nations Environment Programme (UNEP). 2001. Cleaner Production – Key Elements. Available: http://www.uneptie.org/pc/cp/understanding_cp/home.htm

Figure 1.6: The More Efficient Economy



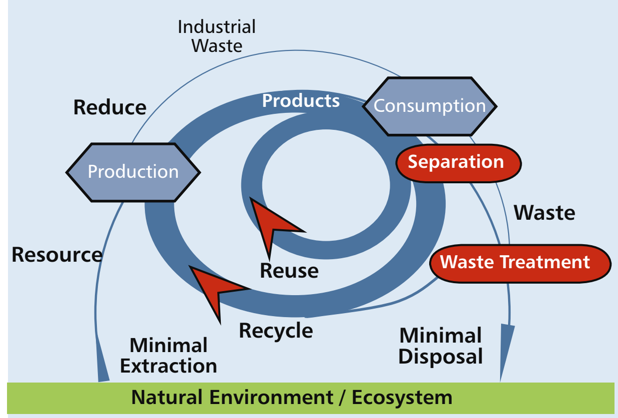
Source: ADB.

environmental compliance is its scope, extending well beyond the factory walls.[12] DfE is associated with a life-cycle perspective because it builds in long-term considerations, from extraction of virgin materials to customer use, to reuse or recycling, and to disposal, recognizing that every engineering decision is also an environmental one. Effective DfE incorporates techniques to help designers improve the environmental performance of their products, such as design for recycling, disassembly, energy efficiency (EE), remanufacture, and disposability. Organizations that describe and discuss DfE and other design issues are proliferating throughout Asia, such as the Thailand Creative and Design Center and the Malaysia Design Innovation Centre.

In addition, consumption-side programs are typically developed at this stage to bring about shifts in purchasing behavior and lifestyle choices. Such measures serve to promote better public understanding of the environmental consequences of the "consumer society." For instance, ecolabeling programs are designed to modify consumers' selection criteria by drawing their attention to the energy consumption of household appliances or sustainable harvesting practices of timber or fish products. Increasing public awareness and attitudes about resource efficiency can also affect a population's willingness to cooperate and participate in local programs, such as segregating waste to assist recycling activities. The emphasis on the consumer side is also apparent in DSM in both the energy and water sectors, often relying heavily on the use of appropriate price signals to influence consumption behavior (page 82).

Figure 1.6 illustrates the achievement of greater resource efficiency by reducing consumption and waste of materials, and by reusing and recycling by-products. By implementing measures on both the production and consumption sides, countries may be able to reduce (per unit of product) both the quantity of the resource extraction stream (lower left) and the quantity and environmental impact of the residual materials flow (lower right) that ultimately reaches disposal sites.

Figure 1.7: The Closed-Loop Economy



Source: ADB.

At the far end of the resource efficiency spectrum is the "closed-loop economy" (Figure 1.7), where nearly all outputs either become inputs to other manufacturing processes or are returned to natural systems as benign emissions rather than as pollutants. For example, a closed-cycle processing plant takes in freshwater and does not discharge any liquid effluents. Rather, the water is constantly recycled and possibly utilized in the final product itself.

It should be noted that achieving truly closed cycles is difficult, if not impossible, for many raw materials and industrial processes, although technological advances are leading to greater reuse rates (page 121). However, the **pursuit** of such systems has transformed entire industries. The pulp and paper industry, once an energy-intensive and

[12] Graedel, T., and B. Allenby. 2003. *Industrial Ecology*, 2nd Edition. Englewood Cliffs, New Jersey: Prentice Hall. Chapter 8.

highly polluting industry throughout the world, was forever changed when it was found that the residues from chemical pulping—so-called "black liquor"—could be recovered and used as a fuel along with bark and other wood wastes. Modern pulp and paper mills now derive a significant portion of their internal energy requirements from such renewable wood by-products, while water consumption in new plants has dropped precipitously as pollution treatment requirements are less. As a result, the sector is no longer considered a dirty industry.[13]

While no country has come close to reaching an advanced stage in applying closed-loop economic principles, some countries, such as the Netherlands are beginning to take the needed steps to get there (page 44). Japan, Germany, and, recently, the PRC have created laws and resource-based policies under such terms as the sound material-cycle society (page 60) and the circular economy (page 48). In addition, companies in Europe, Japan, United States (US), and elsewhere are seizing competitive advantage through the higher resource productivity created by improved resource efficiency.

Industrial Ecology and Systems Approaches

The realization that industrial systems can mimic biological ecosystems, in which one organism's waste is the source of food for another organism, led to the concept of industrial ecology (IE). IE is a philosophy and a field of research and practice that examines industrial systems in the context of the natural, social, and economic systems that surround them.[14] The term was coined in the small municipality of Kalundborg, Denmark, where a well-developed network of dense firm interactions was encountered.

One of the strengths of IE is its systems view of patterns of production, consumption, and resource recovery, all perceived in their context in natural systems. It is systems science applied to the management of human activity as a subsystem of natural systems (Box 1.4). This integrative function may be the unique contribution of industrial ecology to environmental management. In their textbook, *Industrial Ecology,* Graedel and Allenby provide the following short definition of IE:

> Industrial ecology is the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural, and technological evolution. The concept requires that an industrial system be viewed

Box 1.4: Systems and Systems Science

What are systems? What is systems science? These words are overused and often abused. Following is a brief introduction to their meaning.

Below are some of the basic elements of a system:

- A system is a set of elements interrelating in a structured way.
- The elements are perceived as a whole with a purpose.
- The elements interact within defined boundaries.
- The behavior of the system results from the interaction of the elements and between the system and its environment (system + environment = a larger system) .
- The properties of a system emerge from the interaction of its elements and are distinct from their properties as separate pieces.
- A system's behavior cannot be predicted by analysis of its individual elements.
- The definition of the elements and the setting of system boundaries are subjective actions. Conflicts often develop because different parties have defined very different systems without realizing it. Thus, the assumptions of the definers or observers of any system must be made explicit.

Systems science ranges from highly theoretical work defining research methods to applied work in virtually all areas of life (often called "systems practice"). Some modes of applying systems thinking include the learning organization, systems dynamics, sociotechnical systems, and the viable system model.

In this time of complex and rapid change, systems thinking has immediate, pragmatic value for companies and agencies of any size. Understanding that we construct a system from a particular point of view is crucial to working with systems thinking and industrial ecology. This concept often helps to resolve conflicts between different points of view.

Source: Lowe, Ernest, John Warren, and Stephen Moran. 1997. *Discovering Industrial Ecology: An Executive Briefing and Sourcebook.* Cleveland, Ohio: Battelle Press.

[13] World Energy Council. 1995. *Global Energy Perspectives to 2050 and Beyond*. London.

[14] Brewster, J. Allen. 2001. Industrial Ecology and Its Relationship to Cleaner Production. Paper delivered at International Conference on Cleaner Production, Beijing, People's Republic of China. September.

> not in isolation from its surrounding systems, but in concert with them. It is a systems view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal. Factors to be optimized include resources, energy, and capital.[15]

Like any living system, a community consumes material and energy inputs, processes them into usable forms, and eliminates the wastes from the process. This can be seen as "metabolism" of industry, commerce, municipal operations, and households. Understanding the pattern of these energy and material flows through a community's economy provides a systemic reading of the present situation for goal and objective setting and development of indicators for sustainability (Chapter 9 for a discussion of industrial metabolism).[16]

One of the basic principles of systems approaches like industrial ecology is that planning for greater resource efficiency and reduced pollution must be integrated across resource flows, economic sectors, public and private activities, and both short- and long-term time horizons, as discussed in Chapter 3. At its highest level, a systems perspective can be used to pursue greater resource efficiency across whole countries and regions, thus allowing policy makers and investors to

- understand short-term decisions in the context of their long-term implications,
- identify regional and global impacts of local actions and the nature of global impacts on local systems, and
- gain practical whole systems guidance on investment in environmental and energy technologies and services.

In this way, policies, investments, and action strategies can be developed in a holistic context, not in isolation. Otherwise, improvements in one realm may create major problems in another. For instance, a technology for producing ethanol from energy-dedicated crops like corn may cost more in energy, land, and water inputs than it yields in energy.

This report will not dig deeply into the rich field of science surrounding industrial ecology and industrial metabolism. However, it is important to acknowledge that pursuing greater resource efficiency across whole countries and regions is a complicated undertaking requiring highly advanced processes and methods for analysis. It is not simply a matter of measuring materials flows (although that is important), but also understanding the relationship between economic activities and materials flows and appropriate pricing, and the importance of spatial scales, trade flows, and the interactions between stakeholders.

Why Should Asian Countries Care About Resource Efficiency?

Practicing resource efficiency is not simply a response to environmental objectives; it very much concerns questions of economic competitiveness and sustainable economic growth. Following are several reasons why Asian countries should care about resource efficiency.

Tackling local environmental problems. The inefficient use of resources can lead to environmental burdens. Environmental effects include a host of localized environmental problems, such as high levels of urban air and water pollution, floods induced by solid waste clogging drainage canals, reduced availability and quality of freshwater supplies, and land degradation. High pollution levels put public health at risk, which translates into economic costs that are higher than what society would be willing to bear if prices were appropriate and decisions were made with full information about these consequences. According to recent estimates, government spending on environmental protection amounts to less than 1% of GDP in Asia and the Pacific, while the region's economies are losing as much as 8% of annual national growth due to environmental degradation.[17] In September 2006, the PRC released its first assessment of the cost of pollution in the country. Based on the report, PRC's

[15] Graedel, Tom, and B.R. Allenby. 1995. *Industrial Ecology*. Englewood Cliffs, New Jersey: Prentice Hall.

[16] Indigo Development. Available: http://www.indigodev.com/Sustain.html

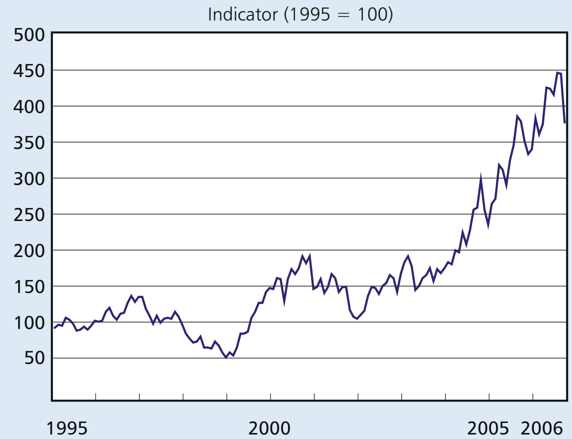
[17] Boyd, Alan. 2002, 26 November. *Environmental Cost of Asia's Development*. Asia Times Online. Available: http://www.atimes.com/atimes/Asian_Economy/DK26Dk01.html

pollution caused $64 billion worth of environmental damage (3.05% of GDP) in 2004. The PRC is the first country to assess the cost of its pollution; the benefits are the creation of a model for developing countries and the advancement of public and business awareness.[18]

Addressing climate change. Some of these costs are visible at the global scale. Emissions of carbon dioxide and other GHGs are accelerating global warming. Because of increased use of fossil fuels, Asia's global share of GHG emissions grew from 8.7% in 1973 to 24.4% in 2003 and is expected to increase to 30% by 2030.[19] Improved resource efficiency is a key strategy to help move economies in Asia and the Pacific onto a lower carbon path, because efficiency measures can greatly reduce GHG emissions from energy generation and use, materials extraction and processing, transportation, and waste disposal. (See page 26 for a more detailed discussion of climate change.)

Source: ADB.

Figure 1.8: Brent Crude Prices (1995–2006)



Source: International Monetary Fund. Primary Commodity Prices. Available: www.imf.org, downloaded 9 October 2006;

Ensuring energy security. By depending on fossil fuels and inefficiently using (especially imported) energy supplies, countries become more exposed to price and supply fluctuations that can undermine energy security. Amid rising natural gas and oil prices and increasing geopolitical tensions, countries can dampen their demand for oil, electricity, and natural gas by renewing their emphases on EE measures (page 72). This is especially important for countries, such as those in the Pacific, that import a large portion of their energy supplies.

Preserving natural capital. There is a strong economic incentive to use renewable resources, such as water and forests, efficiently, guided by principles of sustainable water and land conservation planning. Future economic development depends on conservation of such natural capital assets and the services they provide to the economy.

Improving economic competitiveness. Continued growth of the economies of the PRC, India, and other large developing countries is resulting in higher commodity prices. As many countries in Asia enter more resource-intensive stages of development, they will be especially affected by competition for ferrous and nonferrous metals and plastics. These countries will also have to cope with

[18] 3R Knowledge Hub Secretariat. 2007. *Gap Analysis in Selected Asian Countries*. Bangkok: Asian Institute of Technology (AIT).

[19] ADB. 2006, April. *Report of the Energy Efficiency Initiative. Manila*. Available: http://www.adb.org/Documents/Reports/Energy-Efficiency-Initiative/execsum.pdf

Source: ADB.

the long-term upward trend and volatility of oil prices (Figure 1.8). As a result, resource efficiency has become a major determining factor in the competitiveness of firms and nations.

Minimizing disposal costs. Overreliance on simple waste disposal is unsustainable. Countries cannot afford to build landfills or incinerators fast or safely enough to solve their waste dilemmas if current waste generation rates persist, especially in the face of continuing "not in my back yard" attitudes. Waste disposal must be viewed as just one part of an integrated waste management program. (See page 59 for a discussion on waste management.)

Developing new business opportunities. Many profitable business opportunities are available both in input-efficient production and in environmentally responsible recycling and waste disposal. Developing countries in the region should take full advantage of their chance to leapfrog over conventional solutions to more profitable and sustainable opportunities, such as resource recovery and waste-to-energy schemes. More advanced economies in the region should promote new technologies and technology transfer in the areas of "green" chemistry, biotechnology, nanotechnology, and renewable energy. (See Chapter 8 for a discussion of some of these opportunities.)

Pursuing social benefits. Developing countries can benefit from viewing the environment industry as a potential source of employment and long-term asset protection. The potential exists to improve social conditions while protecting the environment. Given that the Asian region is the world's fastest-growing market for environmental goods and services, there will be significant and growing opportunities for Asian-based small and medium-sized enterprises (SMEs) to meet local demand. Increasing employment opportunities and reducing environmental impacts from harmful wastes are two key factors in reducing poverty, thus contributing to achievement of the MDGs.

Avoiding resource conflicts. Environmental degradation could lead to intensified competition for scarce resources in certain regions. Should the grimmest scenarios come to pass, climate change may intensify already-worrying trends, such as desertification, sea-level rise, more frequent severe weather events, and shortages of freshwater (page 28). In turn, this could lead to violence over scarce necessities. In the worst scenarios, civil wars, uncontrollable migration, and global violence could ensue. Improved resource efficiency would lessen such pressures and help to avert some important root causes of social conflict.

Chapter 2. Resource Use and Efficiency

Asians are producing and consuming more, but the economies of most Asian countries are still based on an inefficient growth pattern featuring a linear and wasteful one-way flow of resources. Per unit of output, developing countries use far more energy, raw materials, and other resources in producing goods and services than do their counterparts in developed countries.

This chapter explores the efficiency (and inefficiency) of use of material, energy, and water resources in Asia and the Pacific. Inefficient use of resources in the region is due to such factors as weakly enforced environmental laws, subsidies and other inappropriate price signals, inadequate knowledge of available clean technologies, low levels of environmental awareness, and poor enterprise management.[20]

Materials

As countries in Asia experience an increase in material consumption and a related increase in the residuals (wastes and polluting emissions) from material extraction, production, and use, their governments are realizing that new strategies must be followed to achieve more efficient and cleaner use of both renewable and nonrenewable materials.

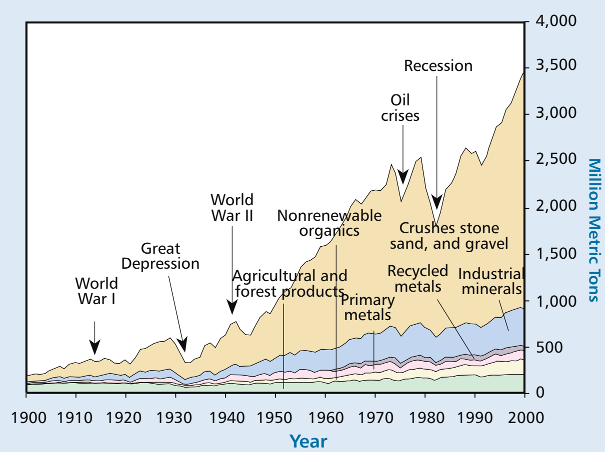
Material-Use Patterns in Asia

As economies of developing Asia continue to grow, the default assumption is that they will follow similar raw material consumption trends as those experienced in the US and other industrialized countries over the last century. As shown in Figure 2.1, raw material consumption in the US dramatically increased as the economy expanded, despite periods of economic downturns.

In addition, as is already being witnessed, the types of materials needed to sustain growth in Asia are shifting to nonrenewable resources, i.e., those that form over geologic time. Construction materials, such as crushed stone and steel, are needed for roads, bridges, and buildings. Cement is needed for ready-mix concrete; ferrous and nonferrous metals for machinery; oil for petrochemicals; potash and phosphate for fertilizer; gypsum for drywall and plaster; fluorspar for acid; soda ash for glass and chemicals; and sulfur, abrasives, and various other materials for use in chemical manufacture.

Another regional and global trend is the increased use of nonrenewable organic materials, which are derived from feedstocks of petroleum, natural gas, and coal, for nonfuel applications. These

Figure 2.1: US Flow of Raw Materials by Weight (1900–1998)



Source: US Geological Service.

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20 UNEP. 2000, April. *Promoting Cleaner Production Investments in Developing Countries: Issues and Possible Strategies*. Paris.

Table 2.1: Contribution to Global GDP and Resource Demand for Asian Economies

	Contribution to Growth, 1991–2004		
Region	**Gross Domestic Product (GDP)**	**Petroleum Demand**	**Steel Demand**
World	100.0	100.0	100.0
Developing Asia	41.2	63.0	75.3
East Asia	26.3	36.0	65.3
South Asia	8.9	9.8	3.7
Southeast Asia	5.1	12.8	6.3
Central Asia	0.3	-2.3	–

– = no data.

Source: Park, Cyn-Young. 2006. Asia's Imprint on Global Commodity Markets. Paper presented at the International Conference on Sustainable Resource Management, Raw Materials Security, Factor-X Resource Productivity -Tools for Delivering Sustainable Growth in the European Union. Bruges, Belgium, 6–7 December.

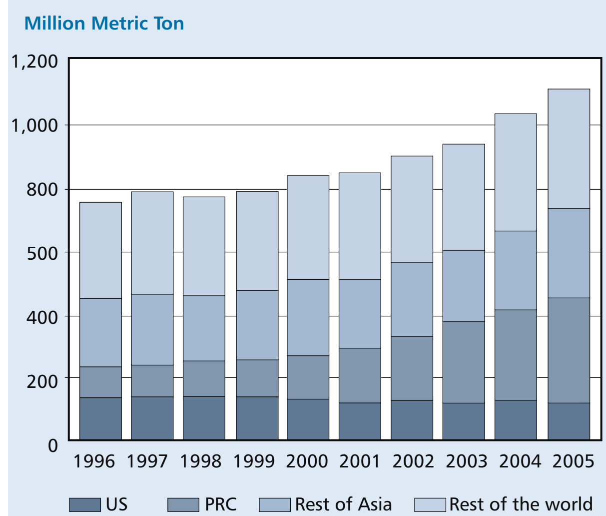
include resins used in the production of plastics, synthetic fibers, and synthetic rubber; feedstocks used in the production of solvents and other petrochemicals; lubricants and waxes; and asphalt and road oil.[21] New materials have replaced old because of cost advantages and/or more desirable properties. Synthetic fibers are replacing natural fibers and plastic is often replacing wood, metal, and other mineral-based commodities.

Source: ADB.

A recent study showed that the demand of petroleum and steel in East and Southeast Asia is proportionately much larger than these regions' contribution to the world economy (Table 2.1). This suggests that the current stage and pattern of economic development in Asia is highly resource demanding.

The demand for resources in the PRC is particularly eye-opening. The PRC is currently in the middle of its most commodity-intensive stage of development and is using staggering amounts of nonrenewable materials. In 2003, half of the world's cement output, a third of its steel, a quarter of its copper, and a fifth of its aluminum were consumed in the PRC.[22] And as shown by Figure 2.2, PRC's consumption of steel continues to expand relative to the rest of the world. Even if PRC's demand for raw materials slows, India's economy is now taking off. India's demand for raw

Figure 2.2: World Consumption of Steel (1996–2005)



PRC = People's Republic of China, US = United States.

Source: World Coal and Steel Institute.

[21] Wagner, Lorie. 2002, February. Materials in the Economy—Material Flows, Scarcity, and the Environment. *US Geological Survey Circular* 1221. US Department of the Interior.

[22] PriceWaterhouseCoopers. 2004. *The China Challenge: Opportunity & Risk in the World's Fastest Growing Market*. Available: http://www.pwc.com/Extweb/manissue.nsf/docid/8FC5CCD285CC07CACA256F1E000DE9AD

Box 2.1: Copper Mining—Problems and Prospects

Most of the increased consumption of copper will take place in developing countries. Consumption in the People's Republic of China and India will increase from 2 million metric tons (Mt) and 400,000 tons in 2000 to 5.6 Mt and 1.6 Mt, respectively, in 2020. Much of this projected copper consumption will have to come from mine production from reserves because recycling of copper is still limited, as is the availability of substitute commodities.

To meet anticipated copper consumption between 2000 and 2020 and to maintain a proportional amount of reserves will require more than three times the amount of copper contained in the five largest deposits currently known. Although some of this material exists in discovered deposits, much of the material will need to come from undiscovered deposits.

In addition, if current practices persist, mining and milling of copper ores will produce about 130 billion tons of waste rock and 56 billion tons of tailings between 2000 and 2020. Further, copper smelting usually releases both sulfur dioxide and arsenic to the atmosphere and hydrosphere.

Source: AFP.

Source: Menzie, David, Geologist, US Geological Survey. 2006. *Hearing on Energy and Mineral Requirements for Development of Renewable and Alternative Fuels Used for Transportation and Other Purposes*. Speech before the House Resources Committee, Subcommittee on Energy and Mineral Resources. 18 May.

materials could triple over the next 10 years as capital expenditure and infrastructure spending increase.[23]

It is important to note that despite the increase in demand for nonrenewable resources, the world still has abundant supplies of most mineral resources (fossil fuels are discussed separately in the energy section below), although rapid increases in consumption may lead to temporary shortages of certain mineral resources. One of the main challenges over the coming decades will be discovering new mineral deposits (Box 2.1). Such deposits will be more difficult to discover and will likely be more costly to produce. Production will depend on such factors as adequate levels of mineral exploration, development of new technologies for mineral discovery and extraction, and social and legal environments governing mineral exploration and production.[24] However, the pace of mine development may become slower and the costs higher.

In addition, conventional development, operation, and closure of mines have very high environmental, social, and economic impacts on communities and their regional ecosystems. Pollution of air, groundwater, and surface water often creates dead rivers, toxic water supplies, and barren landscapes. Economic benefits of mining seldom reach local communities. In response to these problems, the international mining industry has launched a major initiative to define sustainable mining policies and practices.[25]

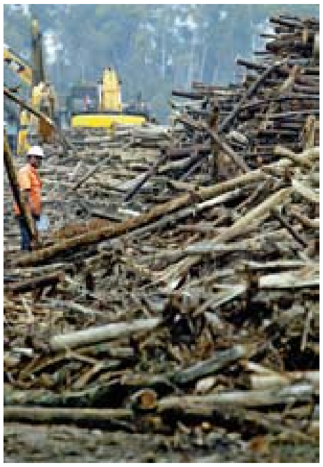
Many countries in the region have also wasted or are in the process of squandering their renewable resources by harvesting and using them in unsustainable ways. Renewable material resources are those that regenerate themselves, such as agricultural, fishery, forestry, and wildlife products. If entire ecosystems are destroyed, losses of species and ecosystem services can be irreversible.

An example is the loss of forest resources in the Philippines. In the 1960s and 1970s, the Philippines was a regional leader in timber exports, selling about 10 million cubic meters yearly. However, due to unsustainable and corrupt management practices and a failure to invest in the industry, forest resources dwindled and exports fell to less than a tenth of that level by 1980. The Philippines must

23 *The Economist*. 2006. More of Everything: Does the world have enough resources to meet the growing needs of the emerging economies? 16 September.

24 Menzie, David. 2006. Hearing on Energy and Mineral Requirements for Development of Renewable and Alternative Fuels Used for Transportation and Other Purposes. Speech before the House Resources Committee, Subcommittee on Energy and Mineral Resources. 18 May.

25 Mining Minerals and Sustainable Development. 2002. *Breaking New Ground*. Available: http://www.iied.org/mmsd/


Source: AFP.

now import most of its wood resources, buying from countries that reforested (e.g., Australia, Malaysia, and New Zealand) at a time when Asia-Pacific demand for wood-based panels, paper, and paperboard has exploded.[26] Unfortunately the damage from deforestation does not stop there—watersheds are invariably degraded, causing even more economic and environmental problems. The burning of formerly forested lands also releases large quantities of carbon dioxide, contributing to climate change. The experience of the Philippines provides an important lesson for still forest-rich countries, such as Cambodia, Lao People's Democratic Republic (Lao PDR), Myanmar, Papua New Guinea, and Solomon Islands.[27] If there is a shift to the use of plant and crop-based resources for energy and chemical products, as is expected over the coming decades (page 42), then the management of renewable resources will become even more vital.

Throughout the region and the world, continued growth in the use of renewable resources will inevitably lead to expansion in the size of developing countries' "ecological footprints," a measure that attempts to weigh humanity's past and present demand on the Earth's renewable natural resources.

An ecological footprint, either on a national, regional, or global scale, is the total area required to produce food and fiber, absorb waste from production and consumption, and provide space for the built environment and infrastructure. Although footprints are not among the agreed indicators of the MDGs and require difficult and debatable estimations, they can nonetheless be used as indicative yardsticks. Freshwater consumption is not included in the ecological footprint.

One of the most powerful uses of the ecological footprint approach is in the assessment of sustainability. By comparing the ecological footprint with biocapacity (the available supply of natural resources), it is possible to assess the ecological sustainability of current consumption—if demand is greater than supply, the level of consumption is not sustainable.[28]

In its recent *Living Planet Report*, the World Wildlife Fund (WWF) reports that humanity's footprint first grew larger than global biocapacity in the 1980s and that this overshoot has been increasing every year since. According to their estimates, we are now spending nature's capital far faster than it is being regenerated. In 2003, the global ecological footprint was estimated at 14.1 billion global hectares, or 2.2 global hectares per person (a global hectare is a hectare with world-average ability to produce resources and absorb wastes), while the total supply of productive area, or biocapacity, was only 11.2 billion global hectares, or 1.8 global hectares per person. Water resources are not included in these calculations.[29]

Furthermore, increases in per capita consumption, in Asia and elsewhere, will enlarge both per capita and national footprints substantially. The Worldwatch Institute estimates that if everyone on the planet were to reach the current consumption level of the affluent nations with the highest ecological footprints, we would need the resource equivalent of five Earths to support it. On a planet that is reaching its limits, nations must learn to plan strategically how to achieve far more resource-efficient economies, and then commit the financial resources and develop the political will to implement their strategies before it is too late.

Waste Generation in Asia and the Pacific

As income levels and consumerism have increased, Asia and the Pacific have also witnessed an expansion in the volume of waste and a diversification of the types of wastes generated in daily life—similar to waste generation patterns in developed countries. Although developing countries still have lower rates

26 Mercado, Juan L. 2004, 14 November. *Stumbling into National Hara-kiri.* Sunstar Cebu. Available: http://www.sunstar.com.ph/static/ceb/2004/11/14/oped/juan.l..mercado.html

27 Ibid.

28 http://www.steppingforward.org.uk/tech/index.htm

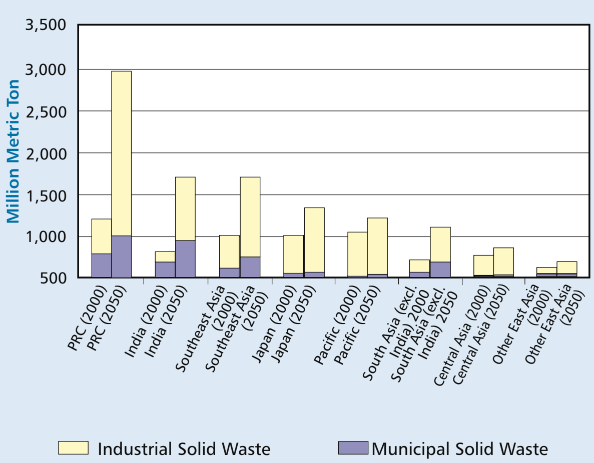
29 WWF International, Zoological Society of London, Global Footprint Network. 2006. *Living Planet Report.* Gland.

of per capita waste generation than do developed countries, urbanization is accelerating and industrial and manufacturing sectors are expanding at rates that far exceed the capacity of many developing countries to cope with the resulting environmental stress and degradation. Most cities throughout Asia and the Pacific are struggling to cope with already overflowing landfills.

For a long time, the main concern in Asia and the Pacific was receiving hazardous wastes unloaded by developed countries. More prosperous countries and cities have practiced a strategy of "out of sight, out of mind," mostly through industrial relocation and waste export. While it has improved environmental quality in places that export pollution, this process has had negative social, economic, and environmental effects on places that receive the waste or host the industries (this issue is discussed in more depth in Chapter 10).

While this remains a significant problem in the region, Asian countries also have to manage increasing amounts of waste that is generated within their own boundaries as they reach middle-income status and become more urbanized (Figure 2.3). In addition, as countries develop, their waste composition changes, which compounds their waste disposal challenges. These changes typically include a decline in the percentage of compostable matter, a substantial increase in use of paper and paper packaging, and a higher proportion of plastics, multimaterial items, and "consumer products" (along

Figure 2.3: Projected Solid Waste Generation in Asia (2000–2050)



PRC = People's Republic of China.

Source: Solid Waste Projection Study by Tanaka et al.

Source: AFP.

with related packaging materials). As countries in the region develop, their waste streams, which previously included mostly organic material from garbage and farm residues, increasingly include medical, electronic, and construction and demolition waste.

However, it should be noted that low-income countries still have a high (40–70%) proportion of compostable organic matter in their urban waste stream (Table 2.2 on page 20), and this effects the technologies and processes that should be employed.[30] This is especially true in agricultural economies like Lao PDR, Myanmar, and Nepal. Higher organic matter in the waste stream results in high waste density (weight to volume ratio) and high moisture content. Systems that operate with low-density wastes, such as in industrialized countries, will not be suitable or reliable in many low-income countries. Instead, biological treatment, such as composting and biogasification (i.e., anaerobic digestion) is more suitable. Further, wastes with a high water or inert content will have low calorific value and also not be suitable for incineration.[31]

Unfortunately, only a few Asian cities, such as Hong Kong, China; Singapore; and Tokyo, have adequate solid waste disposal facilities. Most cities in the region are not taking adequate measures to dispose of their waste safely, nor are they doing enough to divert the organic fraction of their waste from landfills by composting or other appropriate

30 Shastri Applied Research Project (SHARP). 2005, June. *SHARP Profile*. Available: http://www.sici.org/2004shastri/PDF/Engaging%20Communities%20in%20Solid%20Waste%20Management.pdf

31 Zurbrügg, Christian. 2002, November. Urban Solid Waste Management in Low-Income Countries of Asia: How to Cope with the Garbage Crisis. Presented for Scientific Committee on Problems of the Environment (SCOPE), Urban Solid Waste Management Review Session. Durban, South Africa.

Table 2.2: Waste Composition in Urban Settings of Asia

Country	Waste Categories (average percentage of wet weight)					
	Organic	Paper	Plastic	Glass	Metal	Others
Bangladesh (urban)	70.0	4.3	4.7	0.4		20.6
PRC (using coal)	65.0	9.0	13.0	2.0	1.0	10.0
PRC (using gas)	41.0	5.0	4.0	2.0	1.0	47.0
Indonesia (urban)	65.0	13.0	11.0	1.0	1.0	9.0
Japan	17.0	40.0	20.0	10.0	6.0	7.0
Korea, Republic of	31.0	27.0	6.0	6.0	7.0	23.0
Malaysia	43.0	24.0	11.0	3.0	4.0	15.0
Philippines	41.0	19.0	14.0	3.0	5.0	18.0
Singapore	44.0	28.0	12.0	4.0	5.0	7.0
Thailand	40.9	12.1	10.9	6.6	3.5	17.2
Viet Nam	49.0	2.0	16.0	7.0	6.0	20.0

PRC = People's Republic of China.

Source: Compiled from information in 3R Knowledge Hub Secretariat. 2007. *Gap Analysis in Selected Asian Countries*. Bangkok: Asian Institute of Technology.

means (see Chapter 6 for discussion of solid waste management practices in developing countries). Ever-increasing quantities of waste could prove disastrous in these countries unless policy frameworks for environmental protection and occupational health and safety are improved and enforced.

Different types of wastes that countries must manage are discussed below. Some waste statistics from the two leading generators of waste among developing countries in the region—the PRC and India—are presented in Figure 2.4.

Municipal solid waste. Municipal solid waste (MSW) is generally defined as waste collected by municipalities or other local authorities. However, this definition varies by country. Typically, MSW includes household waste; commercial/institutional waste; and waste from municipal services, such as street cleaning and maintenance of recreational areas. It even includes metal scrap from old vehicles, which is posing a problem in the Pacific Islands (Box 2.2). It typically excludes waste from municipal sewage networks and treatment, and municipal construction and demolition waste.

Among Asian countries, there is a marked range of waste generation per capita. MSW generation rates and composition are related to the rate of urbanization, the types and patterns of consumption, household revenue and lifestyles, and waste management practices.[32] Waste generation rates can also differ among cities in the same country.

Industrial solid waste. While the generation of industrial solid waste (ISW) differs greatly among countries in Asia, in general, far more ISW is generated in Asian countries than MSW, in some cases by a large margin. For instance, the generation ratio of municipal waste to industrial solid waste is estimated to be 1:7 for the PRC[33] and 1:8 for Japan.[34] Industrial solid waste includes a variety of materials, most of which are not hazardous or toxic. These include packaging materials, paper, food wastes, resins, plastics, metal and plastic scraps, wood waste, fly ash, bottom ash, boiler slag, and gangue.[35] Like MSW, the generation of ISW differs

32 OECD Factbook. 2006. *Economic, Environmental and Social Statistics*. Available: http://oberon.sourceoecd.org/vl=52787404/cl=12/nw=1/rpsv/factbook/07-01-03.htm

33 Huang, Qifei, Qi Wang, Lu Dong, Beidou Xi, and Binyan Zhou. 2006. *The current situation of solid waste management in China*. J Mater Cycles Waste Management, pgs 63–69.

34 UNEP International Environmental Technology Centre and ASEAN Working Group for Multilateral Environmental Agreements. 2002. State of Waste Management in South East Asia. Available: http://www.unep.or.jp/ietc/publications/spc/State_of_waste_Management/index.asp

35 Gangue is rock surrounding a mineral or precious gem in its natural state. Slag is composed of vitreous materials that contain impurities from ore and form on the surface of molten metals. Fly ash is the finely divided mineral residue resulting from the combustion of

Figure 2.4: Waste Statistics in the PRC and India

PEOPLE'S REPUBLIC OF CHINA

Municipal solid waste. In 1981, the quantity of MSW collected and transported was 26.1 million metric tons (Mt). In 2002, it was 4.2 times that amount, representing an annual rate of increase of 8.2%, higher than the average annual rate of population increase of 4.4%.

Industrial solid waste. The People's Republic of China (PRC), along with India, is unique in the region in that it traditionally uses coal as a household fuel source. The coal mining and processing industry generated the most industrial solid waste (ISW) among industrial sectors, producing 16.0% of the total. The largest component of ISW is mining gangue, followed by coal gangue and coal ash. The recycling rates of these categories of waste are low—8.48%, 32.0%, and 36.2%, respectively.

E-Waste. The PRC had the highest growth in number of computer users per capita during 1993–2000. It grew a massive 1,052%, compared to a world average of 181%. In addition, of global personal consumption items, roughly 20% of mobile phones and 23% of televisions (TVs) were sold in the PRC. In 2003, an estimated 4.48 million personal computers (PCs), 33.5 million TVs, 9.76 million refrigerators, 7.56 million washing machines, and 0.65 million air conditioners became obsolete in the country. Further, the total e-waste from these sources is expected to increase from 55.95 million units in 2003 to 105.28 million units by 2010, an increase of 88% within 7 years.

INDIA

Municipal solid waste. Waste generation rates vary in relation to the cities sizes. Data show average rates of 0.21 kilogram (kg)/person/day for cities of 100,000–500,000 people and 0.5 kg/person/day for larger cities.

Industrial solid waste. There are about 13,000 producers of hazardous waste that generate approximately 4.4 Mt of hazardous waste per year. While many producers have been granted permission to temporarily store hazardous wastes on site, this method has become permanent in many cases.

E-Waste. The annual growth rate of PCs in use has been estimated to be 25%, while for TVs, refrigerators, and washing machines, it is 15–20%. The obsolescence rate of PCs is about 7 years while for the remaining items it is about 15 years. The e-waste inventory is expected to be 16 Mt by 2012.

Agricultural waste. Agriculture in India contributed high methane (a greenhouse gas [GHG]) levels from livestock (45%), paddy cultivation (22%), and biomass burning (15%). Indian farming generated nitrogen oxide (N_2O), another GHG, from nitrogen fertilizer (60%), biomass burning (10%), fertilizer production (11%), and livestock (9%).

Note: The effective application of material resource efficiency requires an understanding of existing and future waste generation and its composition. However, statistics on waste generation is currently hard to come by. It is based on available data, which varies significantly from country to country. In most Asian developing countries, common challenges in properly classifying waste includes the following: (i) There is no system to identify and classify waste into domestic, commercial, and/or industrial wastes. Typically, all types of solid waste are mixed together and not sorted, and there is usually no differentiation during collection by public or private contractors; (ii) The nontoxic or nonhazardous waste generated by various industries is included in the municipal solid waste stream; therefore, it is difficult to obtain data of the industrial waste separately. As a result, the exact rate of industrial waste generation in many countries is not known; (iii) Different ways of classifying and defining hazardous wastes have led to some difficulties in creating a uniform database for hazardous waste in the region.

greatly among countries in Asia and also between rural and urban environments. The categories of ISW in a country are closely related to its level of industrial development and industrial structure.

As countries in the region develop further, there will be a substantial increase in ISN generation, which will pose a serious challenge to those countries that do not have adequate waste collection, transportation, and processing and disposal systems. Many countries need to increase the conversion of ISW into usable resources or energy. Examples of such use are fertilizers, building materials, and road materials.

Hazardous waste. As Asian countries continue to develop, the region will generate more toxic chemicals and hazardous waste. Ensuring the proper management of hazardous waste is a fast-evolving area. Most hazardous waste comes from industrial, agricultural, and manufacturing processes, and from hospitals. Products and industries that generate a high volume of hazardous waste include chemicals, petrochemicals, petroleum, metals, electronic manufacturing, transport, wood treatment, pulp and paper, leather, textiles, and energy production.[36]

By volume or weight, hazardous wastes account for a low percentage of total waste generated (hence

powdered coal in electric generating plants and boilers.

[36] Ibid.

Box 2.2: Metal Scrap on the Pacific Islands

Pacific islands are overloaded with metal scrap from old vehicles. Based on a recent analysis, about 75,000 metric tons of scrap metal exist on Saipan, Guam, and Palau; 35,000 metric tons on the Federated States of Micronesia; and 35,000 metric tons on the Marshall Islands.

The process of reducing this waste stream is encumbered by such complexities as

- unevenly developed disposal systems (including significant unregulated dumping);
- relatively recent interest in integrated sold-waste management plans; hence, the absence of requirements that maximize the streams of scrap through source-separation or waste-stream-separation processes;
- incomplete and insufficient scrap-cost-recovery tariffs;
- burgeoning populations (with attendant increases in waste production);
- real estate limitations for solid-waste disposal sites;
- relatively small-scale scrap streams, resulting in efficiency-of-scale limitations; and
- scrap-recovery inefficiencies related to remoteness from principal scrap-processing centers.

There are some recent signs of progress. Recently, the United States Environmental Protection Agency awarded $30,000 to the Electicore Consortium to organize a scrap material-recycling program in the Pacific called the Green Island Alliance. Consolidating the scrap material from various islands will make recycling economically feasible, create jobs, and facilitate the sustainability of a regional recycling program.

In January 2005, a new law took effect on Guam that requires advance disposal fees on automobiles, trucks, heavy equipment, automotive batteries, tires, and certain other goods. The law requires consumers to pay deposits ranging from $3 for a tire up to $200 for a car or truck. The funds will be used to dispose of the items properly, including the abandoned vehicles, refrigerators, and tires that dot Guam's landscape.

Sparked by the increased demand for commodities in the growing economies of the People's Republic of China and India, the private sector in New Zealand and Australia has stepped in to help Pacific countries solve this problem. For instance, the American Samoa Power Authority (ASPA), which manages a scrap metal yard, sends several shipments of scrap metals to Sims Pacific Metals, the most widely known company buying scrap metal in the region.

Sources: Environment News Service. 2005, 8 February. EPA Funds Pacific Islands Scrap Metal Recycling Survey. Available: http://www.ens-newswire.com/ens/feb2005/2005-02-08-09.asp#anchor6
http://sprep.org/solid_waste/documents/Solid%20Waste/Guidelines/The%20Scrap%20Metal%20Recycling.pdf

the need to evaluate these wastes separately), but their generation is rising rapidly as chemical use in products and processes becomes more generalized. Where industrial or other hazardous waste is mixed in and dumped openly with the rest of the municipal waste, the entire waste stream becomes "hazardous," because it is not feasible to separate it from mixed waste.

While many industries under foreign direct investment in developing Asia are, if anything, more modern (and lower waste) than their counterparts in the developed world, some industrial locations far from the free-trade centers and coastal port areas still serve as pollution havens. Many factories in developing countries do not have access to disposal services for solid industrial toxic waste, forcing many to use rivers, landfills, or open burning. Some hazardous industrial waste is also stored on site without an adequate form of management.

Electronic waste. Harmful chemicals are also increasingly embedded in common products and everyday processes. There are growing problems related to commercial users of chemicals and the use of toxics from consumer products that are discarded or recycled. One prominent example is electronic waste (or E-waste), which can contain more than 1,000 different substances, many of which are toxic (e.g., arsenic, mercury, cadmium, beryllium, and hexavalent chromium). E-waste includes discarded mobile phones, audio-video equipment, PCs, copiers, and household appliances.

One of the more troubling aspects of e-waste is the incredible rate at which it is accumulating.

The electronics industry is the world's largest and fastest growing manufacturing industry. Meanwhile, the lifespan of the products is dropping. As a consequence, e-waste is one of the fastest growing waste streams in the industrialized world.[37] While most of the attention in the region is focused on imports from the US and other developed countries, Asian nations also have to manage the increasing amount of e-waste that is being generated on their own soil. E-waste is discussed in detail in Chapter 10.

Medical waste. The management of medical waste poses a major problem in most countries in the region. Large urban hospitals can generate more than 2 million tons (Mt) of waste, including dressings, needles, medicines, pharmaceutical products, human tissues and liquids, and even radioactive wastes yearly.[38] The quantity and composition of medical waste varies depending on the size of the establishment, proportion of in- and outpatients, type of institution and specialization, available waste segregation options, proportion and use of reusable items, and the prosperity of the country.

The problem of medical waste, however, is not as much about quantity as it is about the nature of the waste and the way it is disposed. Largely as a result of a lack of waste segregation practices in most hospitals, waste from hospitals poses significant health threats. Oftentimes, hospitals simply dump all their waste streams together, from reception-area trash to operating-room waste. As a result, many hazardous materials are mixed into general solid waste for disposal in municipal bins, are mixed into wastes which are incinerated as potentially infectious waste, or are flushed down wastewater drains that flow directly to open sewers or rivers. Such practices represent serious health hazards to workers and to the public and diminish the possibility of recovering some parts of the waste stream for recycling.

Source: C. Visvanathan.

In many countries, such as India, Malaysia, Thailand, and Viet Nam, incineration is a common method of treatment. Many of the incinerators lack pollution control equipment to capture targeted pollutants, such as dioxins, mercury, and cytotoxic emissions. The expansion of the private health sector and proliferation of unregistered clinics have aggravated this problem.

Agricultural waste. Conventional petrochemical farming generates a varied mix of material wastes, many of which may damage rural ecosystems, degrade farmland, and pose risks to human health. Non-crop agricultural waste includes toxic waste (pesticides, herbicides, fungicides, chemical fertilizer, and motor oil); discarded chemical containers; plastics, such as silage wrap, bags, and sheets; used packaging; old machinery; used oil; and veterinary medicines like antibiotics and growth hormones (through animal waste or discard of the medicines themselves). Residual chemical and oil supplies are often dumped on the land or in waterways. Crop wastes include spoiled food, stalks, leaves, tree and vine pruning discards, animal manure, dead animals, and discards from farm food processing. Excess biomass from farm animals and household sewage causes health problems and nitrogen-rich runoff that contaminates groundwater and surface water.

Soil degradation from overproduction, chemical fertilizers and pesticides, and low input of organic soil building amendments is itself a major waste of a scarce resource. Chemical farming weakens soil structure and quality, enabling more rapid erosion and lowering productivity over time. GHG emissions are another important farm waste, coming from animal manure, some farm chemicals, composting, and farm equipment. This is especially true for concentrated animal feeding operations, such as feedlots, factory chicken farms, and dairies.

37 Basel Action Network and Silicon Valley Toxics Coalition. 2002, 25 February. *Exporting Harm: The High-Tech Trashing of Asia*.

38 *Health Care Without Harm*. Available: http://www.noharm.org/globalsoutheng/medicalwaste/issue

Construction and demolition waste. Commonly known as C&D debris, construction and demolition waste includes materials produced during the construction, renovation, or demolition of structures. Structures include buildings of all types, both residential and nonresidential, as well as roads and bridges. Components of C&D debris typically include asphalt, bricks, concrete and other masonry materials, soil, rock, wall coverings, drywall, plumbing fixtures, insulation, roofing, shingles, glass, metal, wood waste, carpet, and electrical wires.

In developed countries, such wastes occupy a significant portion of the volume of landfills. Because C&D debris is variously classified as industrial waste or MSW, municipal and national figures vary widely. Although much more C&D discard material is generally reused in developing Asian countries, the construction and demolition process still represents a significant load on landfills and a good opportunity for recycling. The proportion of C&D debris normally increases with economic development because of the construction and renovation that accompanies it. So even those countries of Asia that do not now have a serious problem with the disposal of C&D debris will face a growing problem as they achieve the economic growth they are pursuing.

Energy

Rapid economic growth in Asia, increases in global energy prices, and the growing impact of climate change have made energy supply and efficiency a critical issue in the future of Asian economies, requiring new technologies and new approaches to the efficient use of energy resources.

Increasing EE to wring more value from each primary energy unit consumed has huge environmental and economic benefits. EE measures can ease growth in fossil energy demand and upward pressure on energy prices, reduce or eliminate power cuts, improve energy security, and improve air quality. EE is also a key strategy in combating potential problems associated with global warming.

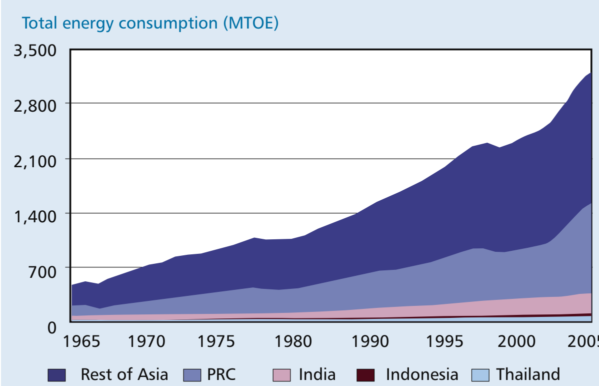
Energy systems are key drivers of economic and social development. Ten billion tons of oil equivalent is consumed per year worldwide to generate electricity and power industrial processes and transportation systems.[39] Securing affordable energy supplies is vital to any countries' economic outlook. Developing energy supplies must proceed along with efficient energy utilization, the development of alternative energy sources, and the reduction of oil subsidies.

Energy Use in Asia

Energy use in Asia is still lower than in other parts of the world but has grown rapidly over the past 30 years (Figure 2.5). During 1973–2003, Asia's energy consumption rose 230%, compared to the average worldwide increase of 75%. Between 2003 and 2030, energy use in the region is estimated to increase another 89%. The region could account for as much as 30% of total world energy consumption by 2030.[40]

The rapid increase in energy demand has led to economic problems in many countries, due in large part to low prices that have encouraged overconsumption. The growing gap between debt burden and revenues has resulted in a financial crisis for many developing-country utilities. Increasing

Figure 2.5: The Growing Demand for Energy in Selected Countries in Asia



MTOE = million tons of oil equivalent, PRC = People's Republic of China.
Source: British Petroleum. 2006. *Statistical Review of World Energy 2006.* London.

39 Gupta, K.P. 2006. *Energy Conservation by Demand-Side Management by Standardization and Energy Labelling*. Gujarat Electricity Regulatory Commission. India Electricity. Pragati Maidan New Delhi. 11–13 May.

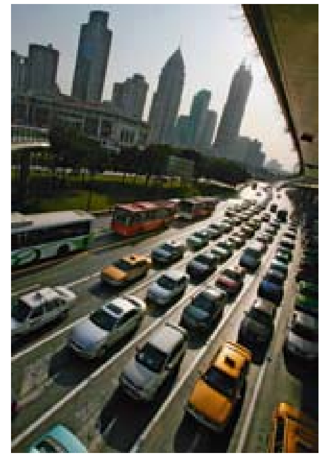
40 ADB. 2006, April. *Report of the Energy Efficiency Initiative.* Manila. Available: http://www.adb.org/Documents/Reports/Energy-Efficiency-Initiative/execsum.pdf

power demand has also created electricity shortages when electricity supply cannot keep up with rising demand. Shortages have led to massive economic losses. In 2004, the PRC experienced a power supply gap of 30,000 megawatts (MW), and more than 27 municipalities, provinces, and autonomous regions had restricted power supplies. Zhejiang suffered from a power shortage of over 7,500 MW, leading to direct GDP losses of 100 billion yuan ($12 billion).[41]

Increased demand for energy will require the region to invest up to $5 trillion in its energy supply by 2030.[42] To meet demands, the PRC's power market will require an average 48 gigawatts (GW) of new capacity every year, equal to two thirds of the United Kingdom's total installed capacity.[43] In India, the soaring power demand will necessitate increasing installed generation capacity from 101,000 to 292,000 MW over the next two decades, even under a best-case scenario that envisions intensified efforts to modernize power plants, improve transmission and distribution efficiency, and adopt more efficient generation technologies.[44]

A large share of the growth in energy demand will be due to rapid industrialization. In most developing countries, energy use in industry outstrips all the other sectors. In India, for instance, industry accounts for as much as 55% of the total consumption, followed by the transport and household sectors.[45] Another important factor increasing demand will be extending energy to the 1.7 billion people in the region who rely on noncommercial energy sources for cooking and heating.[46] This is certainly the case in South Asia, where the challenge will be to provide electricity for the first time to one billion people.

At the same time, energy use for transportation is projected to grow by 6–9% per year in the PRC and 5–8% per year in India. Under a business-as-usual scenario, the total number of cars and sports utility vehicles in the PRC and India combined could rise from around 19 million in 2005 to 273 million by 2035. India is also expected to have 236 million motorcycles in 2035, up from 35.8 million in 2005.[47] Largely because of increased energy use for transportation and also because there are few competitive alternatives to petroleum, emerging Asia (including the PRC and India) is expected to account for 45% of the total world increase in oil use through to 2025.[48]



Source: AFP.

Energy Efficiency in Asia

The transition in many countries from agriculturally-based economies to more industrialized and urbanized societies has been largely marked by inefficient use of energy resources. Despite recent EE improvements (Figure 2.6 on page 26), inefficiencies and waste abound during energy production, distribution, and end use. There is a sizeable EE gap in terms of per capita energy utilization between Asian developing countries and developed countries.

On the supply side, the energy conversion process remains inefficient in most developing countries. For instance, the PRC's average efficiency of thermal power generation is 33.8%, 7% lower than that of developed countries.[49] Furthermore, most countries experience energy losses of 20% or

41 Ying, Wang. 2005, 20 Jan. *China Daily*. Spotlight Shone on Energy Conservation. Available: http://news.xinhuanet.com/english/2005-01/20/content_2484389.htm.

42 Ibid.

43 UNEP. 2006, May. Fighting Climate Change through Energy Efficiency: Local Financing to Slash Energy Waste in China, India, Brazil Said Crucial to Forestalling Global Climate Change. Available: http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=477&ArticleID=5276&l=en

44 Ibid.

45 Gupta, K.P. 2006. Energy Conservation by Demand-Side Management by Standardization and Energy Labelling. Gujarat Electricity Regulatory Commission. India Electricity. Pragati Maidan New Delhi. 11–13 May.

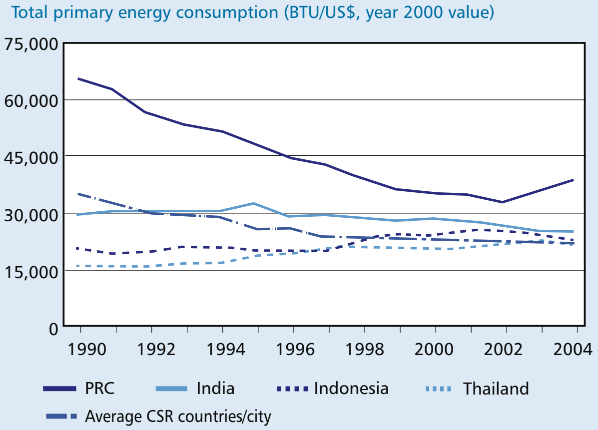
46 ADB. 2006. Toward a Cleaner Energy Future in Asia and the Pacific. Manila.

47 ADB and Department for International Development (UK), in collaboration with the Clean Air Initiative for Asian Cities. 2006. *Energy Efficiency and Climate Change Considerations for On-road Transport in Asia*. Manila.

48 Ibid.

49 Ying, Wang. 2005, 20 Jan. Spotlight Shone on Energy Conservation. *China Daily*. Available: http://news.xinhuanet.com/english/2005-01/20/content_2484389.htm.

Figure 2.6: Energy Intensity in Selected Asian Countries



BTU=British thermal unit, CSR=country synthesis report, GDP=gross domestic product, PRC=People's Republic of China, US=United States, $=US dollar.

Source: Energy Information Administration. 2006. www.eia.doe.gov/emeu/inernational/contents.html

higher during transmission and distribution due to the inherent "line loss" of present best technology.[50]

End-use inefficiencies exist across a broad range of sectors. There are three major energy-intensive sectors—industry, construction, and transportation—and all of them are key factors in maintaining a country's GDP growth rate and improving the daily life of its people. The rapid development of these three sectors creates a growing demand for raw materials, such as steel and cement, as well as for energy, such as electrical power and gasoline.

In the industrial sector, companies typically use inefficient production technologies. Studies indicate that as much as 23% of industrial end-use energy is wasted as the result of inefficiencies.[51] A key strategy to improving EE in this sector is to ensure that funding exists to pay for industrial investment in EE.

In the commercial, governmental, and residential sectors, inefficient buildings are the main culprit. The design, construction, and maintenance of buildings have tremendous impacts on environmental quality, resource use, and human health and productivity. According to the US Department of Energy's Center of Excellence for Sustainable Development, buildings consume 40% of the world's total energy (90% from electric power and about 10% from natural gas), 25% of wood harvest, and 16% of water consumption.[52]

Meanwhile, most cities in the region are following the inefficient transportation patterns of developed countries by becoming increasingly dependent on resource-intensive private transportation instead of on public transport. Transportation is one of the largest and fastest-growing energy users by sector, so changes in transport patterns must play a significant role in reducing energy demands to sustainable levels while simultaneously addressing local air pollution and the threat of climate change.

This situation described above is due in large part to subsidized prices of certain forms of energy, which are maintained to improve industrial competitiveness or to reduce energy cost burdens to household consumers. However, the overall effect is to encourage more energy consumption and to discourage development and diffusion of more energy-efficient and cleaner technologies and policies. Increasing energy prices will make the returns of efficiency-related investments more attractive and provide correct signals to potential investors. (See page 72 for discussion on policies to promote greater EE.)

Climate Change Implications

To meet energy demands, countries in the region are expected to continue their heavy reliance on fossil fuels (Figure 2.7). Energy demands are currently met mainly by coal (41%), oil (25%), and natural gas (7%).[53] The current energy path, which focuses on expanding these fossil fuel supplies, is neither environmentally nor economically sustainable.

The International Energy Agency estimates that cumulative investment in renewable-based energy is likely to reach $1.6 trillion by 2030, with nearly 38% of that allocated to hydro sources. Renewable energy other than traditional biomass is expected to increase from 1,400 metric tons of oil equivalent in 2002 to 2,200 metric tons of oil equivalent in 2030. Despite this significant increase, renewable energy consumption as

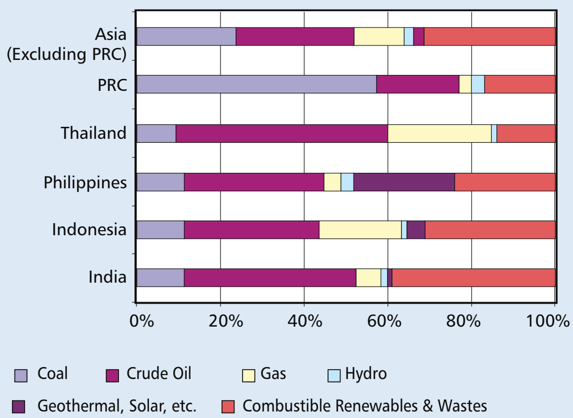
50 ADB. 2006. *Toward a Cleaner Energy Future in Asia and the Pacific*. Manila.

51 United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). 2005. *End-use Energy Efficiency and Promotion of a Sustainable Energy Future*. Bangkok, Thailand.

52 Fahey, Valerie. 2005, 11 September. *Building Green Always Made Sense – Now It's Beginning to Pay Off*. Available: http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2005/09/11/REG-4DEKFQD1.DTL

53 Ibid.

Figure 2.7: Energy Mix in Selected Asian Countries in 2005



PRC = People's Republic of China.
Source: International Energy Agency. 2005. *Key World Energy Statistics 2005*. Paris.

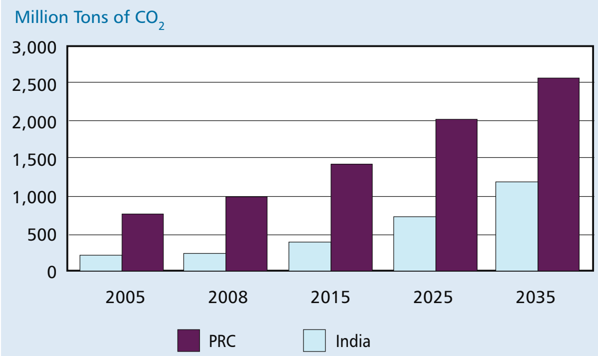
a percentage of overall energy consumption is expected to remain stable at around 14%.

Perhaps the most significant impact of reliance on fossil fuels is emission of GHGs. Climate change concerns have taken a prominent part in development thinking as scientific consensus on the nature and scope of the problem has been reached. Climate change may result in wide-scale changes in the existing environmental and ecological balance, which would, in turn, exacerbate poverty conditions.

Much of the global increase in carbon dioxide emissions over the next 20 years is expected to occur in the developing world, where emerging economies—such as the PRC and India—base economic development on large-scale use of fossil energy derived from hydrocarbons. According to the International Energy Agency, worldwide carbon dioxide emissions are expected to increase by 1.9% annually from 2001 to 2025, while developing countries' emissions are expected to grow by 2.7% annually over the same period. Their emissions may surpass emissions of industrialized countries by 2018 unless significant policy shifts occur.[54]

GHG emissions per unit of GDP, or carbon intensity, in developing Asian countries is typically twice the level in developed countries, reflecting relatively low levels of EE in many sectors. These

Figure 2.8: Total Carbon Dioxide Emissions (Well to Exhaust) from On-road Vehicles in the PRC and India



CO_2 = carbon dioxide, PRC = People's Republic of China.
Source: ADB. 2006. *Energy Efficiency and Climate Change Considerations for On-road Transport in Asia*. Manila.

intensity levels will likely decrease gradually in all countries as they institute EE measures. However, if production and consumption trends in developing countries follow the previous path of developed countries, these improvements will be more than offset by population growth and per capita increases in energy use. For instance, use of cleaner fuels and vehicles may minimize pollution, but gains from these measures will be outstripped by increased motorization unless structured change in transport patterns occurs. Emissions from on-road transport alone can be expected to increase by 3.4 times for the PRC and 5.8 times for India between 2005 and 2035 (Figure 2.8).[55]

The assumed continued reliance on coal is a major contributing factor in such estimates. Two thirds of the PRC's energy is now supplied by coal. The burning of coal releases twice as much carbon dioxide per unit of energy as natural gas combustion and also releases harmful sulfur dioxide and particulates that affect local air quality.[56] Between the PRC, India, and US alone, there are announced plans to build 850 new coal-fired plants by 2012, which would emit five times as much carbon dioxide into the atmosphere as the Kyoto Protocol aims to

[54] Energy Information Administration, US Department of Energy. 2004. Available: http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html

[55] ADB and Department for International Development (UK), in collaboration with the Clean Air Initiative for Asian Cities. 2006. *Energy Efficiency and Climate Change Considerations for On-road Transport in Asia*. Manila.

[56] Institute for Global Environmental Strategies, Ministry of the Environment, Japan. and Chinese Renewable Energy Industries Association. 2005. *CDM Country Guide for China*. Available: http://www.iges.or.jp/en/cdm/pdf/countryguide/china.pdf

Source: ADB.

reduce.[57] While coal in the PRC's overall energy mix is projected to decline from 66% in 2002 to 41% in 2030 as the country increases its use of natural gas, oil, hydropower, nuclear power, and renewable energy, its total annual carbon dioxide emissions are still projected to increase from 3,307 to 7,144 Mt. This would make it the leading source of climate-altering gases.[58]

The impacts of climate change are already unfolding sooner than previously anticipated and require proactive planning to prepare for and adapt to the changes. A few of the likely impacts are:

- rise in sea level and chemical and temperature shifts in seawater, affecting coastal areas and islands everywhere;
- increase in air temperatures and more variable, often more extreme, climate patterns;
- higher incidence of extreme weather events, such as typhoons, hurricanes, tornadoes, floods, draughts, heat waves, and cold snaps;
- less reliable access to water for all human and natural uses, with greater variability of rainfall, accelerated glacial melting, and other impacts;
- shifts in wild and farm habitats, with corresponding impacts on crops, biodiversity, and insect pests and weeds; and
- new demands on municipal infrastructure to handle flooding, water shortages, heating and cooling, and water treatment.

The impacts of climate change may be disastrous to developing Asian countries, many of which will be ill-equipped to deal with the resulting effects on agricultural output, labor productivity, health, infrastructure, and internal displacement. Asia's vulnerability to climate change is dictated by its unique physical and socioeconomic attributes, including high population density, relatively low economic development, long coastlines, and the prominence of agriculture and fishing in providing livelihoods. Undoubtedly, the hardest hit will be the poor. This is both because of their more direct exposure to nature and its extremes, such as droughts, heat and cold waves, storms and heavy rainfall, and their greater dependence on natural resources for their livelihoods (e.g., crops, livestock, biomass fuels). The rural poor, in particular, remain extremely susceptible to the short- and long-term changes brought about by global warming and associated effects on weather patterns (e.g., pestilence, incidence of disease and epidemics, and reduced productivity of land and water resources).[59]

In addition to its global warming effects, the combustion of fossil fuels can rapidly degrade the local environment, especially air quality. Many of the cities in Asia face problems with urban ambient air quality and there is increasing evidence that demonstrates the high impact of local pollution on the environment and human health. Ultra-fine particles, such as those emitted by uncontrolled diesel vehicles, have been shown to have particularly high health impacts. PM_{10} (amount of particles of 10 or less micrometers in diameter) average concentrations in many Asian cities still far exceed World Health Organization (WHO) guidelines, which for PM_{10} is an annual average of 20 micrograms per cubic meter (broken horizontal line in Figure 2.9).[60] WHO estimates that urban air pollution contributes each year to approximately 800,000 deaths and 4.6 million lost life-years worldwide. Approximately two thirds of the deaths and lost life-years occur in the developing countries of Asia.[61]

57 Clayton, Mark. 2004. New Greenhouse Gas Emissions from China, India and the US Will Swamp Cuts from the Kyoto Treaty. Christian Science Monitor. 23 December. Available: http://www.csmonitor.com/2004/1223/p01s04-sten.html

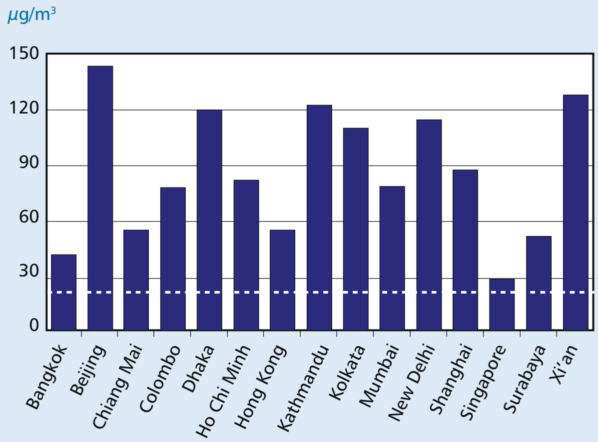
58 UNEP. 2006. *Improving Energy Efficiency in Industry in Asia: A Policy Review.* Bangkok, Thailand.

59 ADB. 2007, April. *Energy for All: Addressing the Energy, Environment, and Poverty Nexus in Asia*. Manila.

60 Clean Air Initiative (CAI)-Asia. 2006. Urban Air Quality and its Management in Asia. Status Report 2006. Presented at the Regional Dialogue of Air Quality Management Initiatives and Programs in Asia. 12 October. Bangkok.

61 World Health Organization (WHO). 2002. *The World Health Report 2002: Reducing Risks, Promoting Healthy Life*. Geneva.

Figure 2.9: Annual Average Ambient Concentrations of PM_{10} in Selected Asian Cities



Note: WHO annual PM_{10} guideline value is 20 $\mu g/m^3$.
PM_{10} = particulate matter with diameter not more than 10 microns, WHO = World Health Organization, $\mu g/m^3$ = micrograms per cubic meter.

Source: Clean Air Initiative-Asia. 2006. Urban Air Quality and its Management in Asia. Status Report 2006. Paper Presented at the Regional Dialogue on Air Quality Management Initiatives and Programs in Asia, 12 October. Bangkok.

In addition, two thirds of acid rain deposition in Asia and the Pacific are presently caused by outdated pollution controls in coal-fired power plants in the region. Rampant oil and coal use, industrial emissions, and biomass burning have caused extensive smog and haze over many Asian cities, such as the infamous atmospheric "brown cloud" stretching over large portions of Southeast Asia. Annual sulfur emissions are estimated to increase from 33.6 Mt in 1990 to over 110 Mt by 2020, a 230% increase.[62]

Another risk of depending so heavily on fossil fuels, and especially oil, is that countries will expose themselves to price and supply fluctuations that can undermine their economic stability and energy security. Delaying preparations for eventual supply gaps could have severe economic and political consequences. After decades of debate about how long the age of petroleum abundance might last, it now appears that the year of peak petroleum production worldwide may be in sight. While nobody knows for certain how much reserve exists, it seems certain that the second half of the oil age will soon commence, characterized by the decline of oil (followed by gas) and all that depends on these prime energy sources (Box 2.3).

Box 2.3: Society's Reliance on Oil

Society's reliance on oil is staggering. Perhaps most important, oil is the source of our mobility. Much of the world's incremental oil demand (as much as half) is projected to be used in the transportation sector, and much of this increase will be due to the rapid increase in vehicle ownership in Asia. What is often overlooked, however, is the use of oil for other common uses. Through refining, petroleum can be turned into many types of petrochemicals, which are used to make hundreds of products often taken for granted. Products that are made at least partially from oil include all plastic products, synthetic fibers (used to make clothes or carpets), shoes, tires, compact discs, fertilizers and pesticides, cosmetics, detergents, and even food additives. Of the projected increase in world oil consumption in 2003–2030, the industrial sector will account for 39%, mostly for chemical and petrochemical processes.


Source: AFP.

Source: Energy Information Association. 2006. *International Energy Outlook*. Available: http://www.eia.doe.gov/oiaf/ieo/oil.html

Several research organizations have offered sobering projections of petroleum reserves and depletion dates. The energy section of the Organisation for Economic Co-operation and Development (OECD) forecasts that peak production will occur between 2010 and 2020, while the World Resources Institute puts the peak between 2007 and 2014.[63] In addition, in 2002, Exxon Mobil published discovery data, with reserve revisions properly backdated, showing that world discovery has been in relentless decline for 40 years. The study showed that existing field production is declining at 4–6% a year, producing a growing gap to be filled by new discovery if projected demand is to be met to 2020.[64]

One day, increasing consumption will collide with a falling supply, which will bring about rapidly rising fossil fuel prices. The effects could be devastating. The permanent terminal decline of our oil-based economy could remove the confidence in perpetual

[62] ADB. 2007. *Energy for All: Addressing the Energy, Environment, and Poverty Nexus in Asia*. Manila.

[63] Kerr, R. 1998. The Next Oil Crisis Looms Large—and Perhaps Close. *Science* 281 (August 21): 1128–1131.

[64] The Association for the Study of Peak Oil and Gas. 2005. Newsletter No. 50. February.

Box 2.4: ADB's Energy Efficiency and Sustainable Transport Initiatives

The Asian Development Bank (ADB) launched the energy efficiency initiative (EEI) in 2005 to explore ways to expand ADB's public and private sector investments in energy efficiency (EE) projects with the goal of expanding ADB's annual investments to $1 billion to improve both supply-side and end-use EE and to fund clean/renewable energy projects. EEI is developing country specific strategies to promote clean energy projects in the People's Republic of China, India, Indonesia, Pakistan, Philippines, and Viet Nam. Additional resources are being mobilized to focus on smaller countries. Helping to fund EEI is a financing facility with a targeted size of $250 million to finance: (i) smaller energy efficiency investments; (ii) technology costs; and (iii) grant assistance for activities such as advocacy, institutional capacity building, project preparation, and establishment of ADB's monitoring and evaluation mechanisms.

ADB is also developing a sustainable transport initiative, which will act as the focal point in the organization for transport-related activities and their impacts on energy use and the environment. The links between air quality, energy production and consumption, and the use of motorized transport are clear, and this initiative will develop new policy and investment options for improving energy efficiencies in transport.

Sustainable urban transport will increasingly become an area of activity for ADB because this is where energy use and pollution from the transport sector are most concentrated. Transport solutions to meet the increasing travel demand must look toward mobility strategies that are more energy efficient. This will require an integrated approach, linking land-use planning, promotion of efficient modes of public transport, and looking at measures to ensure that private vehicles pay their full transport costs, such as congestion charges or road fees.

Source: ADB.

growth on which the global financial system depends. The transition could very well be marked by significant international tension, the first signs of which are already evident.

The dire outlook described above is not inevitable. With the help of market incentives, appropriate public policies, and new technologies, along with international efforts to reduce demand of fossil fuel use on an equitable and sensible basis, the world can experience a more gradual—and peaceful—transition. EE and the expanded use of renewable energy sources will be at the core of these adjustments (Box 2.4 illustrates some new initiatives by the Asian Development Bank [ADB]). It is estimated that any one of the available global renewable resources employing existing and near-term conversion technologies would be more than sufficient to meet today's global energy requirements and even the level of demand expected by the end of the 21st century.[65] The costs of such a transition will be huge, but the costs of inaction will be even greater.

[65] Eberhard, A., M. Lazarus, S. Bernow, C. Rajan, T. Lefevre, M. Cabrera, D. O'eary, R. Peters, B. Svensson, R. Wilkinson. 2000. *Electricity Supply and Demand Side Management Options*, Thematic Review IV.1 prepared as an input to the World Commission on Dams, Cape Town. Available: www.dams.org.

Water

"The world is heading for a water crisis that is unprecedented in human history. Water development and management will change more in the next 20 years than in the last 2,000 years." Asit K. Biswas, Director, Third World Centre for Water Management[66]

Water Use in Asia

Availability of water is an emerging, if not a present crisis, in many parts of Asia. Certain parts of the region have already started to face water shortages and, if present trends continue, the situation will undoubtedly become worse. Some experts claim that water will soon become one of the major constraints for future economic development.[67] Without major improvements in efficiency of water use, more and more water will be required to meet human needs and future growth and human welfare in the region will be compromised.

[66] Biswas, Asit. 1999. Water Crisis: Current Perceptions and Future Realities in Groundwater: Legal and Policy Perspectives. Proceedings of a World Bank Seminar. Washington, DC.

[67] Shanahan, Mike. 2006. Improve Water Efficiency in Farming, Urges Report. *SciDev.Net*. 23 March. Available: http://www.unu.edu/unupress/unupbooks/80157e/80157E02.htm

Water is a unique resource in a number of ways. Unlike other resources on the planet, water cannot be replaced by an alternative. Water is a vital natural resource with multifaceted uses (e.g., domestic use, industrial use, power generation, recreation, fisheries) cutting across class, economic, and political boundaries. In addition, riparian, marine, and terrestrial ecosystems are important "consumers," whose needs must be met in order to restore and conserve natural capital, which is the ultimate foundation for all economic activity.

Water is also a socially vital economic good and should be managed in an integrated manner and allocated among competent users through participation and negotiation.[68] The quality and quantity of water resources and services, including basic sanitation, are critical to addressing problems of poverty, health, and education and to achieving sustainable and equitable development.[69] Thus, efforts to minimize the amount of water used to produce certain goods or services must take into account issues of environmental sustainability and social equity.[70] Planners must balance all these considerations.

Source: ADB.

The extent of water use for any one purpose varies from one country to another, and is dependent on a variety of factors, including the level of economic development, importance of specific sectors in the national economy, efficiency of water use, and sociocultural practices.[71]

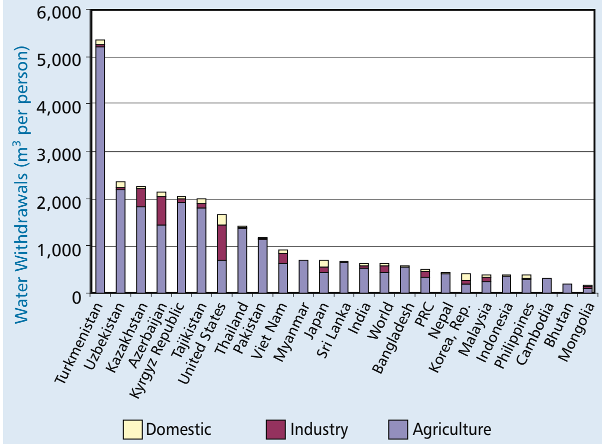
68 ADB's Water Policy. Available: http://www.adb.org/Water/Policy/default.asp

69 ADB. 2006. *Water for All: Translating Policy into Action*. Comprehensive Review of ADB's Water Policy Implementation. Final Report and Recommendations. Manila.

70 Brooks, David. 2002. *Water: Local-level Management.* Ottawa: International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

71 Shanahan, Mike. 2006. Improve Water Efficiency in Farming, Urges Report. *SciDev.Net*. 23 March. Available: http://www.unu.edu/unupress/unupbooks/80157e/80157E02.htm

Figure 2.10: Annual Per Capita Water Use by Sector in Selected Asian Countries



m^3 = cubic meter, PRC = People's Republic of China.
Source: World Resouce Institute Data Tables (http://earthtrends.wri.org/) from Food and Agriculture Organization of the United Nations; data are from 2000.

In developing countries, including those in Asia, by far the biggest use of water is the agriculture sector (Figure 2.10). Agriculture is water intensive. It uses up to 70 times more water to produce food than is used in drinking and other domestic purposes. On average, it takes approximately 1,000 tons of water to grow 1 ton of grain, 2,000 tons to grow 1 ton of rice,[72] and 43,000 tons to produce 1 ton of beef.[73] Water requirements for agriculture depend on different factors, including total land under agricultural production, types of soils and crops cultivated, climate, availability and pricing of irrigation water, efficiency of water use, and management practices.[74]

As populations expand, so too will the demand for water for agricultural uses. For instance, if the pattern of PRC food consumption emulates current US consumption patterns, PRC grain consumption will be 1,352 Mt in 2031 (from 382 Mt), or two thirds of the current global grain harvest.[75] The production of an additional 1 billion tons of grain

72 Ibid.

73 Pimentel, David et al. 2004. Water Resources: Agricultural and Environmental Issues. *BioScience* 54(10): 909.

74 Shanahan, Mike. 2006. Improve Water Efficiency in Farming, Urges Report. *SciDev.Net*. 23 March. Available: http://www.unu.edu/unupress/unupbooks/80157e/80157E02.htm

75 *People's Daily Online*. 2005, 8 September. China Cannot Afford to Follow US Example in Economic Development. Available: http://english.peopledaily.com.cn/200509/08/eng20050908_207306.html

with existing technologies will put great strain on the PRC's water supplies unless drastic measures are taken.

Water Scarcity in Asia

Water is a renewable resource and, unlike nonrenewable resources like oil or natural gas, there is no danger that the world is going to run out of water. However, as the world's demand for water has tripled over the last half century, water is increasingly emerging as a scarce commodity in some places, fueled by population pressures, intensive irrigation, and erratic weather patterns brought on by global warming.

In most places, the best and cheapest sources of water are already overextracted. Rivers have been diverted, lakes have been tapped, and aquifers have been depleted. In some places, upgrading water supply systems amid growing demand have already become prohibitively expensive and, in some cases, environmentally dangerous.[76]

A recent assessment of water management found that a third of the world population is affected by water scarcity.[77] The results of this assessment, which was carried out by 700 experts over the last 5 years and spearheaded by the International Water Management Institute (IWMI), showed that one quarter of the world's population lives in river basins where water is physically scarce. In these places, water is overused, leading to falling groundwater levels and dying rivers that no longer reach the sea. Another 1 billion people live in river basins where water is economically scarce. In these places, water is available in rivers and aquifers, but the infrastructure is lacking to make this water available to people.[78]

Compounding the problem of water quantity is one of quality. Water quality in many places in the region is deteriorating due to industrial discharge, municipal sewage, and overload of fertilizers and agrochemicals (Box 2.5). Despite progress made so

Source: AFP.

Box 2.5: Water Pollution in Viet Nam

Almost all river basins in Viet Nam are polluted with residential and industrial waste. In Ha Noi, Ho Chi Minh City, and other major cities, residential, hospital, and industrial wastewater remains untreated, flowing directly into lakes and canals crossing residential and production areas. Over 70% of industrial zones and 90% of production units do not have adequate waste treatment facilities. As a result, millions of cubic meters of untreated raw sewage are discharged into the surrounding environment every day, polluting Viet Nam's major rivers, including the Cau, the Nhue-Day, and the Saigon-Dong Nai.

The Viet Nam Environment Water Monitoring 2004 reported that industrial parks and export processing zones in the Southern Key Economic Zone discharge over 137,000 cubic meters of wastewater containing nearly 93 tons of waste into the Dong Nai, Thi Vai, and Saigon rivers each day. Meanwhile, only 2 of 12 industrial parks and export processing zones in Ho Chi Minh City, 3 of 17 in Dong Nai, 2 of 13 in Binh Duong, and none in Ba Ria-Vung Tau have wastewater treatment facilities. Not surprisingly, pollution levels in almost all major rivers for most pollutants are higher than the national water quality standards. In rural areas, water bodies are also polluted from household and livestock waste, as well as pesticides and insecticides. Only 30–40% of rural households have access to clean water, and only 28–30% have sanitary latrines.

Sources: Ministry of Natural Resource and Environment. 2004. *Vietnam Environment Water Monitoring*. Ha Noi.

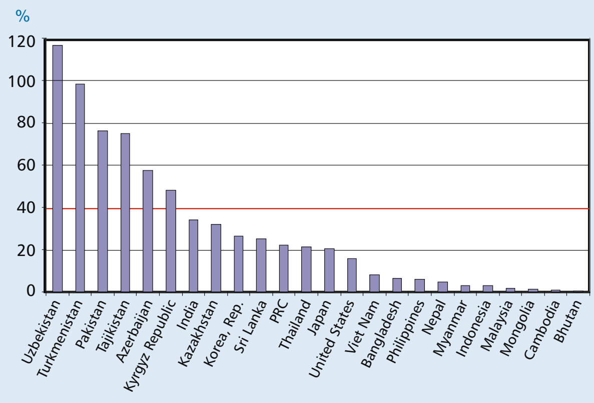
Ministry of Natural Resource and Environment. 2004. *Report on 10 year Implementation of Law on Environmental Protection*. Ha Noi.

76 Brennan, Donna. 2001. Australian Centre for International Agricultural Reseach. Water-policy Reform Issues: An Overview. Prepared for International Workshop on Water Policy Reform: Lessons from Asia and Australia. Bangkok, Thailand. 8–9 June.

77 Global Policy Forum. 2006, 21 August. *A Third of the World Population Faces Water Scarcity Today*. Available: http://www.globalpolicy.org/socecon/envronmt/2006/0821waterstudy.htm

78 Ibid.

Figure 2.11: Annual Water Withdrawals as a Percentage of Annual Water Resources in Selected Asian Countries (2000)



PRC = People's Republic of China.

Source: World Resource Institute Data Tables (http://earthtrends.wri.org/) from Food and Agriculture Organization of the United Nations; data are from 2000.

far, approximately 700 million people in the region were without access to safe drinking water, and 1.9 billion lack sanitation facilities.[79] Poor water quality reduces the useable quantity of water even further, so addressing water quality must be a key strategy in addressing water supply.

According to one United Nations (UN) indicator, a country can be considered to be water scarce if total withdrawals are greater than 40% of annual water resources. As is shown in Figure 2.11, drier basins in Central Asia are among those most at risk The Aral Sea is perhaps the most glaring example (Box 2.6). However, shortages are even occurring where rainfalls and river volumes seem abundant. For instance, development in Cambodia's section of the Mekong Delta had proceeded for years on the assumption that monsoon rains and seasonal river flooding reliably recharge groundwater and the underlying aquifer. Research now demonstrates that the Mekong replenishes only a narrow strip of the adjacent aquifer, and rainwater is quickly shed by a layer of impermeable clay. [80]

According to Lester Brown, president of the Earth Policy Institute, the depletion of fossil aquifers, which are nonreplenishable, would bring water pumping to an end, yet many countries, such as the PRC and India, continue to deplete them anyway. In a survey of India's water situation, the 21 million wells drilled are lowering water tables in most of the country, *New Scientist* magazine recently reported. Pakistan, which is also mining its underground water, is experiencing similar water table issues. Observation wells near the capital Islamabad show the water table sinking 1–2 meters a year during 1982–2000.[81]

Perhaps the most severe effects will be felt in agriculture. If underground water sources dry up entirely, farmers will have to rely on surface water, but in more arid regions, the loss of irrigation water could mean the end of agriculture. As water shocks become food shocks and as falling water tables translate into higher food prices, the world could change fundamentally almost overnight. [82]

Water supply interruptions in water-short areas could also have profound negative effects on industry. In the PRC, for instance, supply interruptions may occur in six

Box 2.6: The Aral Sea Disaster

When the former Soviet Union diverted the Ama Dariya and the Syrdariya rivers, which fed the Aral Sea, they created an ecological and human disaster. What was the fourth biggest inland sea is now mostly desert.

Decades of heavy irrigation have raised the water table and brought all the salts the soil held to the surface. Tuberculosis is rife and on the increase. Cancers, lung disease, and infant mortality are 30 times higher than they used to be because the drinking water is heavily polluted with salt, cotton fertilizers, and pesticides.

Source: AFP.

All of this was done in the name of cotton—grown where it would not grow naturally. It remains the main source of income for the newly independent republics. By changing farming methods, they have slowed down the rate of shrinking. Still, it will be years yet before what is left of the sea begins to grow again.

Source: Welsh, Paul. 2000. *The Aral Sea Tragedy*. BBC News. 16 March. Available: http://news.bbc.co.uk/1/hi/world/asia-pacific/678898.stm

79 ADB, UNDP, UNESCAP, and WHO. 2006. *Asia Water Watch 2015*. Manila. Available: www.adb.org/Documents/Books/Asia-Water-Watch/default.asp

80 Brooks, David. 2002. *Water: Local-level Management.* Ottawa: International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

81 Rizvi, Haider. 2007, 28 July. OneWorld.net. *Washington Pressed to Lead as Water Tables Fall*. Available:http://www.iwmi.cgiar.org/Press/coverage/pdf/Washington%20Pressed%20to%20Lead%20as%20Water%20Tabl.pdf

82 Ibid.

industries that account for approximately two thirds of all industrial water demand—electric power, iron and steel, petroleum production and refining, chemicals, paper making, and textile dyeing. Such shortages will have far-reaching economic impacts, as investment projects will risk brownouts and interruptions.[83]

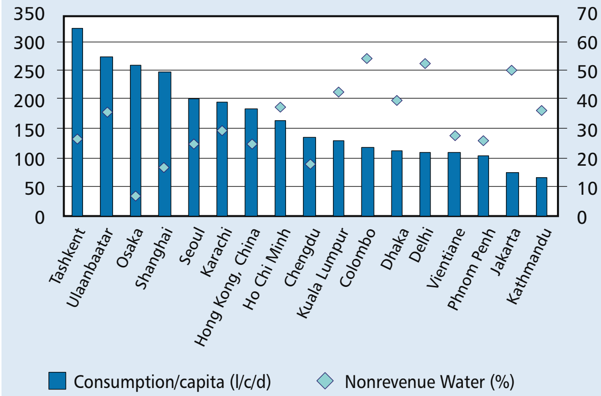
In addition, while the world's attention is focused on record high oil prices, water is increasingly emerging as a catalyst for international instability. In the 21st century, Asia may become a focal point of water-related conflict given the rapid growth of the region, the concentration of long-standing internal and inter-state tensions, and the lack of cooperative management mechanisms. Three regions in Asia are the most likely candidates for water-related conflict: Central Asia, South Asia, and the Mekong subregion in Southeast Asia.[84] Water disputes could exacerbate current tensions in these regions.

If current trends continue, the shortage of water will extend well beyond the semi-arid and arid regions. Potentially compounding the problem, climate changes linked to global warming may lead to shortened rainy seasons and longer droughts, which will provoke new economic, social, and health crises. Therefore, it is imperative that countries start getting the most out of the water supplies that they have. New water supplies are likely to result from conservation, recycling, and improved water-use efficiency rather than from large development projects.

Water Inefficiencies in Asia

To combat these problems, some countries in the region are focusing on expanding water supplies and irrigation networks, but most of these efforts will likely prove to be uneconomical, and some will be environmentally disastrous. Supply-side technological fixes are also costly and are unlikely to significantly enhance production in the foreseeable future. For instance, despite recent technological breakthroughs that have helped reduce costs, desalination of seawater—sometimes embraced as a panacea for water problems—still has many implications, especially in energy and technology management, which need to be carefully assessed before it can be successfully and extensively used on a sustainable basis in Asia.[85]

Figure 2.12: Water Supply Indexes in Selected Asian Cities (Consumption/Capita and Nonrevenue Water)



l/c/d = liters per capita per day.

Source: ADB. 2004. *Water in Asian Cities.* Available: http://www.adb.org/Documents/Books/Water_for_All_Series/Water_Asian_Cities/default.asp (as of 2001 or 2001/2002 fiscal year)

The best, and perhaps only, way to avoid the grim scenario described above is to improve the efficiency of water use. In the agricultural sector, this will involve increasing agricultural yields per unit water used, or in the parlance of IWMI, "growing more crop per drop." The potential for more efficient water use in the agricultural sector and other sectors in Asia is enormous, as some recent statistics suggest:

- In developing countries, as much as 75% of water intended for irrigation, whether from the surface or pumped from the subsurface, is lost to evaporation, leakage, seepage, or simply bad management.[86]
- In many mega cities, including Colombo, Dhaka, Delhi, Jakarta, Kathmandu, and Kuala Lumpur, nonrevenue water of water supply utilities is around 40% or more of production

[83] Butler, Tina. 2005, 30 May. *China's Imminent Water Crisis.* Available: http://news.mongabay.com/2005/0531-tina_butler.html

[84] Bajpaee, Chietigj. 2006. Asia's Coming Water Wars. *The Power and Interest News Report* 22 August. Available: http://www.pinr.com/report.php?ac=view_report&report_id=545&language_id=1

[85] ADB. 2007. *Asian Water Development Outlook: Achieving Water Security for Asia*. Manila. Available: http://www.adb.org/Water/Knowledge-Center/AWDO/AWDO.pdf

[86] Brooks, David. 2002. *Water: Local-level Management.* Ottawa: International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

(Figure 2.12). In many cities, stand-pipe water is free to users.[87]

- Many cities in Asia use around 200 liters per capita (for those connected to piped water). Unlike in Europe, domestic conservation efforts, such as through toilet or shower retrofitting, is limited in the region.[88]

This inefficiency in water use in Asia not only reflects backward production technology but also inadequate water management and institutional arrangements. Despite recent progress in the region, the effectiveness of new water policies in some countries as been limited because policy, legal, and institutional reforms are still lacking and there is no distinction between water as a resource that must be managed and water as a service for delivery.

Many countries lack adequate pricing mechanisms and integrated approaches. The block tariff systems employed by Asian utilities usually have large volumes at lifeline rates, thereby providing subsidies to all, including the rich. In the agricultural sector, cheap and abundant water provides an inducement to implement water-heavy measures. In most countries, relevant authorities have no incentive to take water-conserving measures like supplying water on a volumetric basis, and farmers have no incentive to economize their use of water.

However, Asian countries can take hope in the fact that there is presently enough water to go around. It is possible to reduce water scarcity, feed people, and address poverty over the long term, but this can only happen if tough decisions are made about how to allocate and manage water. There will be trade-offs between city and agriculture users, between food production and the environment, and between fishers and farmers.

The experience in developed countries offers some promise. In the 1960s, the first long-range forecasts of water consumption made in the US predicted an increase in annual freshwater consumption by 2–2.5 times from 1970 to 2000, mainly due to increases in water use in industry and thermal power generation. However, in the 1970s and 1980s, a transition from extensive water resource consumption to intensive and multipurpose water resource use brought about a stabilization of water consumption. Similar trends were observed in northern and western European countries.[89]

Innovative approaches can help Asian countries stabilize their water consumption. Agriculture can be made more water efficient in developing countries if farmers harvest rainwater or use small-scale, inexpensive irrigation technologies. Low-cost technologies will also make it possible to increasingly use urban wastewater. Consumers can switch to more water-efficient household appliances that will raise water productivity. Possible national and local measures are discussed on pages 86 and 109, respectively.

87 ADB. 2004, January. *Water in Asian Cities – Utilities Performance and Civil Society Views*. Manila. Available: http://www.adb.org/Documents/Books/Water_for_All_Series/Water_Asian_Cities/default.asp

88 McIntosh. Arthur. 2003. *Asian Water Supplies, Reaching the Urban Poor: A Guide and Sourcebook on Urban Water Supplies in Asia for Governments, Utilities, Consultants, Development Agencies, and Nongovernment Organizations*. Manila: ADB and International Water Association.

89 Shiklomanov, I. A. 1994. World Water Resources: Assessment and Prediction. In *Innovation, resources and economic growth,* edited by A. Q. Curzio, M. Fortis, and R. Zoboli. Berlin: Springer-Verlag.

Chapter 3. Adopting Integrative Thinking to Change Perspectives and Decision-Making Processes

The economies of Asia have already entered a period of crisis in their access to the resources needed for continued development, poverty reduction, and environmental protection. Major improvements in resource efficiency—not just modest incremental changes —are essential. Responding adequately demands greater integration and coordination across several dimensions of resource management.

This chapter describes four important dimensions of integration that policy makers need to consider:

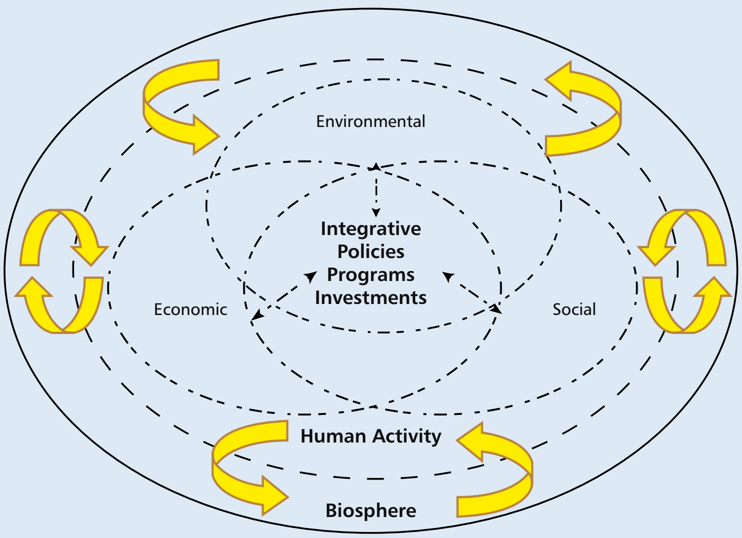
- Integrative planning across economic, social, and environmental spheres;
- Materials, energy, water, and land as integrated systems;
- Integrative planning across naturally defined regions; and
- Integrative planning across time horizons.

Integrative Planning Across Economic, Social, and Environmental Spheres

One of the keys of sustainable development is recognizing that economic, social, and environmental systems are actually complementary, not in conflict. The three systems are coequal and interdependent, with major areas of overlapping interests (Figure 3.1). However, the reality is that integrative planning across these three fundamental realms of sustainable development is a challenge. Experts and other stakeholders in each realm tend to claim that their perspective embodies the most important issues for true sustainability. The priorities for resource efficiency appear quite different when viewed through an environmental lens than through a social or economic one.

Those who are primarily concerned with the environmental dimensions of development tend to place the highest priority on the health of ecological systems and see the economy and society as subsystems of the biosphere. They warn of limits to growth, arguing that there are constraints set by the stocks and flows of natural capital and a regional and global carrying capacity that cannot be exceeded. Exceeding these limits will strain natural systems and could lead to their collapse.

Figure 3.1: Interface of Sustainable Development Dimensions



© Indigo Development 2007

Source: Lowe, Ernest. Indigo Development. 2007. Industrial Ecology: Holistic Framework for Resource Efficiency. Presented at the 3R Workshop on Effective Waste Management and Resource Use Efficiency in East and Southeast Asia, ADB Headquarters in Manila, Philippines, 15–16 February. Available: www.adb.org/Documents/Events/2007/Effective_Waste_Management/Ernest_Lowe_presentation.pdf that their repair is wrongly measured as contributing to gross national product (GNP). They believe that a healthy market economy will tend to reward ventures that seek to meet environmental and social needs. They also seek to create market incentives that will encourage technical innovations to respond to rising resource prices or to increase resource efficiency. Social scientists and activists make effective governance, social and environmental justice, and equity in income and wealth distribution preeminent. Achieving these goals will assure environmental stewardship and sustainable economies. They are also important to moving toward a much more peaceful world, for communities, cities, and world order.

These often contrasting viewpoints and the difficulty of their integration have sometimes led decision makers to address challenges by taking action in only one of these areas. This risks intensifying problems in the other areas, which in turn can loop back to have negative impacts on the original area of focus. For instance, investments in a new dam to improve water supply in an economy (economic focus) may destroy wildlife habitat (environment). Poverty increases if there are weakly compensated, displaced communities who can find no new land to farm (social). The resulting political instability can translate into significant costs (economic).

Resource efficiency is a clear area where economic, environmental, and social considerations offer overlapping benefits. For those focusing on the environment, high resource efficiency is a way to reduce environmental stress. For economists, high efficiency increases profits and competitiveness. And for social scientists, high resource efficiency can contribute to seeing that everyone has their basic needs met. This should allow actors in the three realms to negotiate creative synergistic solutions, making trade-offs as necessary to move toward increased sustainability.[90]

[90] Schnurr, Jamie, and Susan Holtz, eds. 1998. *The Cornerstone of Development: Integrating Environmental, Social, and Economic Policies.* Ottawa: International Development Research Centre.

The Environment and Poverty

One important link that is just beginning to be fully understood is between the environment and poverty. Due in part to rapid economic growth in many countries, millions of people in Asia have been able to lift themselves out of extreme poverty (those living on $1 a day or less). In 1990, one person in three in the PRC lived in poverty. Today, that number is below one in ten. There is an enormous opportunity to improve the well-being of many more millions of people through further development.

However, environmental degradation and resource depletion threaten these recent advancements. Even as resources continue to be degraded throughout the region, millions of poor people depend on natural resources for their livelihoods and well-being, including products provided by ecosystems (e.g., food, fuelwood, and freshwater), the functions they serve (from regulating the climate to soil formation), and their recreational, aesthetic, and spiritual benefits. As described earlier in this paper, the poor, and especially the rural poor, are also especially vulnerable to future changes, such as seasonal and climatic variation.

Source: ADB.

The challenge of poverty reduction—including promoting the conditions for improved human health, securing the basis of rural livelihoods, and conserving the environment—is particularly acute in Asia and the Pacific. The region is home to half of the world's population, many of whom still live in poverty despite recent economic growth. Can these people be lifted out of poverty while reversing trends in natural resources degradation? Understanding and resolving these relationships holds the key to poverty reduction and better ecosystem management.

Box 3.1: ADB's Poverty and Environment Program

Financed by governments of Sweden and Norway and the Asian Development Bank (ADB) through ADB's Poverty and Environment Fund, the Poverty and Environment Program (PEP) supports demonstration projects and analytical studies and disseminates information on the linkages between the environment and poverty. PEP is now in its fourth year and, thus far, 16 subprojects across the region have been funded for $3.3 million.

The PEP has three components:

- **Targeted analytical studies.** As an example, the *Poverty, Health and Ecosystems* report, jointly published by ADB and the International Union for Conservation of Nature and Natural Resources (IUCN), explores the state of knowledge on the links between poverty, health, and environment. It aims to improve understanding of issues of governance, rights, and responsibilities as fundamental links between conservation and human well-being. The study also explores the role of gender equity; and identifies tools, strategies, and targets to address the links between health, poverty, and conservation.
- **Information Dissemination of Success Stories.** The PEP website (www.povertyenvironment.net) was launched to systematically gather and synthesize knowledge on poverty–environment relationships culled from the experiences of PEP-funded activities, ADB projects, and projects supported by other organizations.
- **Pilot Interventions.** Pilot projects are being implemented in the People's Republic of China, India, Maldives, and Viet Nam. Some of these projects are discussed in the next section.

A number of pilot projects focus on developing sustainable livelihoods for people living around protected areas. One innovative project in Viet Nam is supporting biodiversity corridor development in Lam Dong Province and establish approaches that allow for the integration of protected area management, rural livelihood improvement, and poverty reduction, and support to environment-friendly resource use patterns. The selected biodiversity corridor is located in a central highland area where about 46% of the rural households live in poverty. Pilot interventions include reforestation and forest regeneration (on scrubland and deteriorated protection plots), animal husbandry (cattle and a local small-framed pig species), and farming systems (provision of planting materials for fodder grass and coffee) in combination with a number of technical training courses.

Source: ADB.

This multidimensional approach to poverty reduction has been encapsulated in the MDGs, which include the need to improve not only incomes, but also health, education, gender equity, and environmental sustainability. Many development agencies have now endorsed these goals and are using their achievement as key indicators of progress. ADB is also fostering institutional learning about the links between poverty and environment through its Poverty and Environment Program (Box 3.1)

Deeper structural reforms are necessary in many countries to make further inroads into reducing poverty and unemployment. These include reallocating fiscal expenditures toward programs that favor economic growth and the poor. For instance, businesses in some countries continue to identify lack of investment in infrastructure as a major impediment to business activity and investment (Chapter 7). This serves to drag down economies and ultimately hurts the poor.

At the same time, many policies encourage resource inefficiency. For example, expenditures are still being directed to inefficient fuel subsidies. Whether directly or indirectly controlled, in over half the Asian economies, regulated prices were raised as world oil prices rose. Some governments view price controls and subsidies as an important way of providing support to those on low income, but poor targeting often means that these subsidies are captured by other groups. Since many countries finance their subsidies through the budget, such subsidies not only create perverse incentives but they also divert money from much-needed social programs.[91]

91 ADB. 2007. *Asian Development Outlook 2007 Update.* Manila.

Environmental Protection and Jobs Creation

Another benefit, both to the social and economic spheres, is jobs creation. Contrary to general public opinion, environmental management, regulation, and investment have been shown to create and protect jobs at a significant level. Studies in the US have found that the environmental sector may be larger than previously thought and extend well beyond traditionally identified scientific and physical management jobs. The vast majority of jobs created by environmental protection are standard positions, such as accountants, engineers, computer analysts, plumbers, factory workers, truck drivers, and mechanics.[92]

In addition, job creation and environmental investment are not only compatible, they are strongly synergistic, with investment in environmental programs likely to generate greater than proportionate employment. For instance, the impact of increased sales of water treatment plants, biomass refineries, or air pollution control equipment in Asia will reach far beyond the systems themselves because the installation of these systems requires procurement of large quantities of components and services. Large system suppliers purchase fans, motors, material handling systems, steel structures, vessels, pumps, valves, piping, and instrumentation from other suppliers. For every full-time employee in the primary contractor there are 3–4 full-time employees in the component companies working to supply the needs of the prime company.[93] Thus, developing countries benefit from viewing the environmental industry as a potential source of employment and long-term asset development, improving social conditions while protecting the environment.

Materials, Energy, Water, and Land as Integrated Systems

Integration for resource efficiency in policy making and investment should emphasize interactions and efficiency improvements among the basic resource flows and stocks, including materials, energy, water, and land. When focused on one type of resource, it is important to always consider how it interacts with others, because the production or use of each type of resource places demands on all the others.

The policies and practices of sustainable agriculture illustrate the power of integrative planning and management to achieve high resource efficiency. The transition to sustainable agriculture requires integration and coordination across all the dimensions. Achieving a successful transition requires coordination on a regional or even national scale, working over a long timeframe, and integrating the management of materials, energy, water, and land. It also requires collaboration among different agencies and academic disciplines in policy, research, education, and training.

Sustainable farming practices are not new and are practiced to some degree in traditional farming. However, evolving approaches are allowing farmers to get closer to closed resource cycles as described in Chapter 1. The concept of sustainable agriculture is to work with the farm as an adaptive ecosystem in which the farmer manages all resources as a whole system, reducing external resource inputs and reusing all residues on site or with neighboring farmers. This involves

- restoring and building the soil through ecological methods that blend mineral, bacteriological, and organic amendments as well as cover crops (green fertilizer);
- using water with high efficiency of input per unit of output;
- using renewable energy and minimizing use of petrochemical input;
- utilizing organic residues (biowastes) as input to soil productivity and for production of bioenergy;
- practicing integrated pest management that utilizes natural predators and microorganisms to kill damaging insects; and
- integrating the farm into its ecological context through restoration of wetlands, hedgerows, and marginal plantings of wildlife habitat.

Increasingly, agricultural policies and practices must also take into account the increasing production of biofuels. National officials must answer important

92 Opschoor, Hans. 1995. *Sustainable Growth and Employment.* The Ecumenical Leadership Foundation. Available: http://www.jaysquare.com/resources/workdocs/wdoc11c.htm

93 McIlvaine Company. 2001, January. *U.S. Industry Market Leadership in Asia's Air Pollution Control Sector.* Prepared for the US-Asia Environmental Partnership. Washington, DC.

questions before deciding to promote widespread production. How feasible is development of crop-based biofuels, given the availability of land, water, and fertilizer in a particular country? Is it possible to achieve a net energy gain, or does a planned crop-to-biofuel project use more energy than it creates, thereby actually reducing resource efficiency? Does this land use reduce food security by reducing space for food crops?

There are strong movements to achieve a transition to sustainable farming in a number of Asian countries, including the PRC, India, and Thailand. This transition will lower external resource input costs while increasing competitiveness domestically and in export markets.[94] Specific measures that can be taken to improve materials, water, and energy efficiency in agriculture are presented in Box 3.2.

The use of an integrated approach to resource management is also applicable and highly cost effective for specific real estate development projects, such as apartment building or hotel design. The built environment can use up to 40% of a country's energy supply and a significant volume of water. Construction also uses a large volume of materials and a large area of land. The costs of operating a building's energy and water systems over a lifetime usually surpass its total initial construction costs. This realization has led designers to integrate new (and sometimes old) methods for designing and operating buildings combined with application of renewable energy technologies, resulting in very high resource efficiency.[95] High-performance "green" buildings are discussed in Chapter 8.

Source: AFP.

[94] International Fund for Agricultural Development (IFAD). 2005. *Going Organic in Asia.* Rome: IFAD.

[95] Kibert, Charles J., Jan Sendzimir, and Bradley Guy, eds. 2001. *Construction Ecology and Metabolism: Nature as a Model for the Built Environment.* London: Spon Ltd. (See University of Florida, School of Construction website for other resources on high performance design: http://www.bcn.ufl.edu)

Integrative Planning Across Regions: The Urban to Rural to Wild Continuum

Typical planning processes fragment different types of land use in a region, focusing on urban or rural or wild land without perceiving the interactions among them. Fragmentation is typical across regional economic sectors and land-use types in both developed and developing countries. The result is that farms send food and fiber to urban markets and cities send organic wastes to landfills, incinerators, and sewage treatment plants, but not to the places of origin of the organic materials. In this linear flow, urban waste management pollutes waterways and air and also contributes to GHG emissions. Infrastructure and pricing mechanisms fail to support the return of organic materials to the locations of their highest-and-best use, either as soil restoration nutrients or as energy to grow additional food in a sustainable manner. These failures in regional planning result in low resource efficiency for all types of resources in urban, rural, and wild areas of a region.

Integrative regional planning is a process seeking to optimize solutions by addressing multiple regional issues as a whole system. It may begin with a defined problem or a proposed solution. How do we increase the efficiency of water use by all sectors in our arid region? What government and business support is required for farmers to learn sustainable farming? Can we reduce GHG emissions throughout the region and increase the efficiency of our economy?

One area in which integrative planning is essential is making economic use of the huge amount of biomass waste overloading landfills around the region. The use of biomass residues from urban and rural areas, as well as from wild land, may enable production of major bioenergy and biomaterial products. This will involve system innovations in transport (biofuels), electricity generation (co-combustion, gasification of biomass), agriculture (biocrops), and policy (integral biomass policy regarding energy, biodiversity, space use, agriculture, and transport).[96] The core issue is planning sustainable programs and initiatives to absorb this largest component of both urban and rural waste,

[96] Loorbach, Derk, and Jan Rotmans. 2004, January. *Managing Transitions for Sustainable Development*. International Center for Integrative Studies (ICIS). Maastricht: Maastricht University. Available: www.icis.nu

Box 3.2: Promoting Materials, Water, and Energy Efficiency in Agriculture

Materials. The health of the land itself is a foundation of resource management in sustainable farming. This principle determines many of the practices relating to efficient use of materials. Sustainable farming practices contribute to overall efficiency of materials use by greatly reducing petrochemical inputs (and their containers), recycling on-farm residues, rebuilding and conserving the quality of soil, and preventing its erosion. Fully applied, sustainable farming increases the output per unit of material input and land area.

Following are some basic material resource strategies for sustainable farming:

- Material inputs derive from the farm itself in a closed-loop system, except for special mineral or bacteriological micronutrients and equipment, such as drip irrigation systems and small tractors.
- Plant and animal residues are recycled to build soil quality and productivity (with an option of generating energy through use of digesters), which can reverse the waste of the land resource degraded by conventional farming practices.
- Organic and mineral nutrients are applied with guidance from real-time soil testing to determine the level and balance of nutrient application.
- Integrated pest management eliminates (or greatly reduces) use of polluting chemicals.
- Cropping strategies can increase overall farm output and the efficiency of resource use. These include selection of varieties to grow in each part of the production cycle; crop rotations; and mixing appropriate crops to diversify output, strengthen soil, and reduce risk of pests.

Water. Sustainable farming seeks to minimize external inputs and optimize all resources native to each farm and farm region. For water, some of the basic strategies are:

- Build organic content of the soil and water retention through composting, cover cropping with “green manure” (often with legumes that are plowed under), and minimal cultivation of the surface.
- Practice intensive farming with multiple crops intermixed to increase the output per unit of water and land input (and the resistance to pests).
- Structure fields to minimize erosion and to create ponds and wetlands. (The first two strategies also limit erosion.)
- Use moisture sensors to determine when and how much water to apply.
- Use drip irrigation (low-volume water application) devices, flooding fields only when necessary, and avoid use of sprinklers.
- Capture storm water from rooftops and uncontaminated paved areas and store in ponds or tanks.
- Recycle gray water from households and use low water or composting toilets.
- Reduce loss of water through lining irrigation canals.

Energy. There are three levels of energy inputs to agriculture: (i) the energy required to produce farming supplies; (ii) direct use of fuel and petrochemical products on the farm; and (iii) the energy of cultivation, irrigation, storage, transportation, and processing. Producers may achieve more efficient energy use in Asian farming through incremental improvements at each of these three levels. Strategies for optimal energy use are:

- Reduce or eliminate application of artificial fertilizer, pesticides, herbicides, and other energy intensive inputs.
- Use renewable sources wherever possible, especially bioenergy from farm and urban residues (chapter 8).
- Reduce cultivation and plant more diverse crops in a land-intensive mode (thus increasing output per unit of energy input).
- Use relatively lightweight equipment with low energy demand and impact on soils. Revive animal traction for cultivation, harvest, and hauling as feasible.
- Use ground heat pumps to provide baseline energy to households, greenhouses, and farm buildings.
- Produce for local and regional markets and reduce long-distance shipping (except for high-value or value-added products).

continued on next page

Box 3.2 continued

In addition, a major factor in application of energy to farming is the high energy required for meat and poultry production. Therefore, a major way to save energy in the agricultural sector is to end or reduce incentives for factory farm grain-fed meat and poultry production and to provide consumer education for a healthy, balanced diet with an "appropriate" share coming from meat and poultry.

Source for materials and water list: Ernest Lowe.

Source for energy list: International Fund for Agricultural Development (IFAD). 2005, July. Organic Agriculture and Poverty Reduction in Asia: China and India Focus, Thematic Evaluation. *IFAD Report* No. 1664. Available: http://www.ifad.org/evaluation/public_html/eksyst/doc/thematic/organic/asia.pdf

while integrating its use with appropriate bioenergy crop cultivation. This new approach to renewable energy can be integrated into a sustainable regional planning process and avoid the likely negative consequences of fragmented planning.

Development of bioenergy resources is a very active field of both public and private environmental investment on every continent. Increasing concern for the impacts of climate change has driven worldwide interest in growing crops for biofuels. The European Union (EU) adopted a Biofuels Directive in May 2003 to promote the use of biofuels in transport. The US President has presented a "billion ton vision" to produce 1.3 billion tons of dry biomass for the biofuels industry by 2050, providing 30% of US fuel needs. Fifteen percent of US corn production already goes into feedstock for ethanol. In Brazil, 40% of nondiesel fuel is ethanol, produced from sugar cane. The President of Brazil has signed a memorandum of understanding with the US to provide technical assistance to other Latin American countries in development of biofuel crops and processing.

Bioenergy promoters assert that atmospheric carbon can be minimized by investing in energy technologies that utilize crops or other organic by-products. Benefits will be greatest if material outputs from energy processes are used in sustainable soil and landscape restoration. However, increased use of biomass for energy raises serious regional issues. For instance, some leading analysts say that ethanol production from corn requires more fossil energy than the "renewable" energy it yields. They also say that large corn plantations are very damaging to the farm soil, regional waterways, and surrounding ecosystems.[97]

Thus, promotion of biofuels requires a robust regional planning response involving all stakeholders and consultation with national and international sources of scientific validation. This process should address a number of important questions:

- What land will be chosen for these large plantations? What other agricultural and ecosystem functions will be displaced?
- How will the initiative avoid the likely ecological consequences of monoculture plantation tree farming, particularly given the tendency of such species to be invasive?
- How will the initiative planners preserve biodiversity?
- What is the fossil energy balance for the whole process of growing and producing this biofuel? Does it produce more energy than it requires from fossil sources?
- What economic structures can assure that the region and its communities will share in the profits of the enterprise, beyond low-income farm employment?
- How would growing this single biofuel species fit into a comprehensive system for energy generation and fuel production from biomass?
- How would this system benefit from and support sustainable farming in the region?

Integrative Planning Across Time

Policy makers and investors often plan in a relatively short time frame. They make choices that appear cost effective in the present but create major economic or environmental problems in the future. Or they may

97 Pimentel, D., and T. Patzek. 2005. Ethanol Production Using Corn, Switchgrass, and Wood and Biodiesel Production Using Soybean and Sunflower. *Natural Resources and Research* 14(1): 65–76. Patzek, Tad. 2004–6. Thermodynamics of the Corn-Ethanol Biofuel Cycle. Online edition of article first published in *Critical Reviews in Plant Sciences* 23(6):519–567 (2004). Available: http://petroleum.berkeley.edu/papers/patzek/CRPS416-Patzek-Web.pdf

simply not take into account major changes and risks that are on the horizon.

For instance, in the short term, solid waste disposal and sewage treatment demand quick solutions. However, investment in large infrastructure or building projects locks in the environmental, economic, and social impacts of initial planning decisions for decades. Deciding on conventional designs rather than high performance and integrated designs is likely to result in high operating costs and environmental impacts. Thus, investments should be planned in the context of a transition to full resource optimization, with highly successful waste minimization (reduction) and resource recovery (reuse and recycling).

There are many principles, methods, and tools to support long-term planning for investment decisions over time. Three of these are discussed below.

The Precautionary Principle

One of the most basic foundations for evaluating public or private activities and new technologies for resource efficiency is the precautionary principle, adopted into government policy and planning by the European Commission, international agreements, and a number of jurisdictions in the US.

> "The precautionary principle is a general rule of public policy to be used in situations of potentially serious or irreversible threats to health or the environment, where there is a need to act to reduce potential hazards before there is strong proof of harm, taking into account the likely costs and benefits of action and inaction."[98]

Climate scientists have argued for precautionary actions to reduce GHGs for close to three decades. The precautionary principle should also be followed when applying new technology innovations that may lead to future negative impacts unforeseen or denied by their developers. These may include genetically modified crops, some applications of nanotechnology, and overemphasis on substituting biofuel crops for food crops. Policy makers and investors need to work with independent evaluation experts to determine which should be implemented.

Inevitably, this principle provokes controversy, with technology developers insisting there is inadequate proof that the risks will be fulfilled. However, the precautionary principle places the burden of proof on the developer, so long as there is an adequate scientific basis for challenging the innovation.

The European Commission, university researchers, and several nongovernment organizations (NGOs) have developed handbooks and guidelines for using the precautionary principle. These include the Communication on the Precautionary Principle from the European Commission in 2000 and the Council of Ministers Nice Decision, also in 2000. They have made significant contributions to the practical implementation of the precautionary principle, especially concerning stakeholder involvement and the avoidance of trade disputes.

Transition Management

Two institutes in the Netherlands—International Centre for Integrated Assessment and Sustainable Development and Dutch Research Institute for Transitions—have led the development and application of methods for more integrative planning across time under the concept of "transition management."

> "In general terms, a transition can be portrayed as a long-term process of change during which a society or a subsystem of society fundamentally changes. Transitions require system innovations: organization exceeding, qualitative innovations, which are realized by a variety of participants within the system and which fundamentally change both the structure of the system and the relation among the participants. It is within these systemic innovations that innovations at the individual level occur, in terms of product, process and project innovations." [99]

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98 European Environment Agency. 2001. Late Lessons from Early Warnings: the Precautionary Principle 1896–2000. *Environmental Issue Report* No 22. Copenhagen. Available: http://reports.eea.eu.int/environmental_issue_report_2001_22/en

99 Loorbach, Derk, and Jan Rotmans. 2004. *Managing Transitions for Sustainable Development*. January. Maastricht: Maastricht University International Center for Integrative Studies (ICIS). Available: www.icis.nu

Box 3.3: Key Elements of Transition Management

- Systems thinking encompassing more than one domain and different actors at different scale levels; analyzing how developments in one domain or level gel with developments in other domains or levels; trying to change the strategic orientation of regime actors
- Long-term thinking (at least 25 years) as a framework for shaping short-term policy
- Back- and forecasting: the setting of short- and longer-term goals based on long-term sustainability visions, scenario studies, trend analyses, and short-term possibilities
- Focus on learning and the use of a special learning philosophy of learning-by-doing and doing-by-learning
- Creating policies in terms of performance goals rather than specific means or solutions
- Evaluating policies in terms of both achievement of content goals and improvement in processes of governance and institutional learning
- An orientation toward system innovation and experimentation
- Participation from and interaction between stakeholders

Source: Loorbach, Derk, and Jan Rotmans. 2004. *Managing Transitions for Sustainable Development.* International Center for Integrative Studies (ICIS). Maastricht: Maastricht University. Available: www.icis.nu

Transition management (Box 3.3) differs from the conventional planning-and-implementation model seeking particular outcomes. A more process-oriented and goal-seeking framework helps actors to deal creatively with complexity and uncertainty. Action researchers identify three primary coordination mechanisms:

- market price mechanisms and decentralized decision making for making product and service choices;
- planning in the form of transition goals, policy strategies, and objectives that centrally coordinate economic activities; and
- institutional coordination of developing new models for policy; developing transition arenas, agendas, and goals; fostering new networks; and focusing on learning processes.

The Netherlands Government adopted transition management as a national policy in 2001. This policy is being implemented by five ministries that are developing transition policies for mobility, agriculture, energy supply, and biodiversity. Participants have established transition arenas, which are networks of innovators and visionaries that develop long-term visions to serve as the basis for creating transition agendas and transition experiments. They see this as a practical means of achieving sustainability benefits in the long term while maintaining short-term diversity.

Adaptation to Climate Change

One illustration of planning across time relates to one of the most critical challenges facing the world: responding to the present impacts of climate change and preparing for the likely future impacts. We are already experiencing accelerated melting of glaciers and ice sheets, changes in weather patterns, and the beginning of islands sinking below rising sea levels. An Australian report concludes:

> …an adaptation strategy, to be effective, must result in climate risk being considered as a normal part of decision making, allowing governments, businesses and individuals to reflect their risk preferences just as they would for other risk assessments.[100]

[100] Allen Consulting Group. 2005. *Climate Change Risk and Vulnerability: Promoting an Efficient Adaptation Response in Australia.* Report to the Australian Greenhouse Office, Department of the Environment and Heritage. Available: http://www.greenhouse.gov.au/impacts/publications/pubs/risk-vulnerability.pdf

Clearly, policy makers will need to work with all of the other dimensions of integrative planning discussed in this chapter, but climate change adaptation presents a new and crucial challenge. A primary level of adaptation will involve integrated planning across regions. Climate change will affect the production and use of water, energy, materials, and land. Interagency and interdisciplinary collaboration will be vitally important (Box 3.4).

Around the world, the dominant response to climate change has been to seek ways to mitigate GHG emissions through policies, financial instruments, energy conservation, and technical means at all levels of an economy. Many of the measures to mitigate GHGs relate to efficient use of energy and adoption of renewable energy and clean energy technologies.

Source: AFP.

As prices for goods and services are adjusted to take account of the global externalities associated with GHG emissions, this will have a powerful effect on resource efficiency.

With a subject as complex as climate change, it is important to consider diverse scenarios of what may happen and determine what short- and mid-term initiatives are the best investments. In California, for instance, rising sea level and shorter retention of water in snow packs is likely to result in greater flooding. Investment in reforestation to retain water, higher levees along rivers, and constructed wetlands adjacent to rivers are likely to be quite valuable in future years. Dams may need to be raised and strengthened to withstand increased runoff from early snow melt. The PRC's massive floods in recent years suggest similar measures will be required there.

Box 3.4: Steps in Planning for Climate Adaptation

Some of the basic steps in a regional process to prepare and adapt to the impacts of climate change are:

1. Identify the organization that will act as home base for the process and recruit an initial set of stakeholder organizations from public and private sectors.
2. Develop channels of communication and action to involve people and organizations in the planning and action processes of adaptation. Include a web site, speakers' bureau, town meetings, involvement of schools and colleges, and media briefings.
3. Identify current stresses affecting the region, its natural resources, and economic sectors. This baseline assessment investigates such issues as deforestation, water scarcity, air quality, soil degradation, loss of wetlands, and exhaustion of aquifers.
4. Consider how climate variability and climate change might either amplify or mitigate these stresses, or create new ones. This is basically a scenario planning process based on regional application of climate change models by interdisciplinary teams of experts and stakeholders. Alternative scenarios lay out best-case, middle-case, and worst-case possibilities for all key variables.
5. Identify beneficial strategies that will address the likely impacts of climate change and the current stresses analyzed in step 1. Link these strategies with other important trends, like the transition of sustainable farming, energy and water efficiency, the implementation of renewable energy (especially bioenergy) technologies, and sustainable land-use master plans.
6. Create policies, investment strategies, and action plans in each of the major areas of adaptation to climate change. Identify the early "no-regrets" actions that will pay off, however climate change unfolds.

Source: Ernest Lowe.

Links to reports and websites on climate adaptation planning are available at http://www.indigodev.com/prepcc.html

Chapter 4. Developing National Policy Frameworks

To bring about changes in the way countries use resources, it is vital to achieve a collaboration of government, business, civil society, and other stakeholders, all focused on developing and implementing a holistic and coherent national framework for greater resource efficiency.

This chapter looks at the importance of national policy frameworks in achieving resource efficiency. National frameworks range from overall development strategies to specific environmental standards and regulations. Environmental controls can be thought of as relating to "exploitation" (the use of natural resources), "protection" (nature conservation), and "management" (the ongoing protection of the environment from existing activities). Within these categories, governments can influence how pollution is controlled, how natural resources are managed, and how new developments are designed (e.g., through the use of environmental impact assessments and other approval mechanisms).

Until recently, most policy approaches were copied from developed countries. These tended to be traditional command-and-control regulations that dictated actual technologies and acceptable pollution levels. In more recent times, developing countries have begun to amend these standards to make them more specific to their own circumstances. They are also trying new approaches, such employing financial and economic measures to complement their regulatory regimes, promoting voluntary initiatives, and utilizing information-based measures

However, despite recent progress on the policy front in many Asian countries, existing policies to be need to be analyzed and changed, as many of the current problems are a legacy of pricing policies that do not provide adequate incentives for conservation and efficient resource allocation. The lack of enforcement throughout the region, as well as corruption, weak courts, and lack of access to information also need to be addressed. This is the topic of the next chapter on Institutional Arrangements.

This chapter discusses overarching policies and strategies to promote resource efficiency. It stresses the importance of quantifying problems, setting targets, and monitoring progress toward achieving them through benchmarking. Four types of policy instruments are discussed—regulatory, economic, information-based, and voluntary—that governments can develop and implement to promote greater resource efficiency. Finally, the chapter looks at policies that help determine efficiencies of material, energy, and water use.

Overarching Policies Promoting Resource Efficiency

For the necessary reforms to occur, legislators and other stakeholders must first see resource efficiency as a means to improve environmental quality and then establish policies through legislation or executive order mandating an integrative approach for all agencies and establishing capacity-building programs to support it. Integrated policies and regulations can optimize resource efficiency programs and can help avoid transferring burdens from one resource to another. Such policies should seek to optimize overall resource consumption, integrating materials, energy, water, and land use. They should also allow development of integrated systems solutions for water and solid waste management. To help accomplish this, developing countries should review the advanced principles, methods, and tools on integrative planning being implemented in Asia, Europe, and North America, such as the precautionary

Box 4.1: Life-Cycle Impacts of Societal Consumption in the European Union

The Environmental Impacts of Products (EIPRO) project of the European Union (EU) recently analyzed 11 individual studies that looked at the life-cycle impacts of total societal consumption and the relative importance of different final consumption categories. What they concluded revealed much about the patterns of consumption and their relative impacts on efficiency of use of resources.

Across all studies, a limited number of priorities emerged in terms of resource use. They found that three main goods or services—housing, transport, and food—were responsible for 70% of the environmental impacts in most categories, although they covered only 55% of expenditure in the 25 countries of the EU. At a more detailed level, highest priorities for attention were automobiles and air travel within transport; meat and dairy products within food; and building structures, heating, and electrical energy-using products within housing. Expenditures on clothing, communication, health care, and education, while large in monetary terms, were considerably less important in terms of their resource use and environmental impacts.

While the developing countries of Asia have different priorities at present from those of the EU (e.g., such items as vehicles and meat are not currently as great a proportion of resource use), the rapid changes in consumption patterns in Asia are carrying them inexorably toward the patterns of the developed nations.

Unlike most studies done in the past 25 years on similar topics, these studies addressed a broad set of environmental impacts beyond just energy use or carbon dioxide emissions. The studies differed greatly in basic approach (extrapolating life-cycle analysis data to impacts of consumption categories versus approaches based on environmentally extended input-output tables), geographic region, disaggregation of final demand, data inventory used, and method of impact assessment.

Source: Tukker, Arnold, and Bart Jansen. 2006. Environmental Impacts of Products: A Detailed Review of Studies. *Journal of Industrial Ecology* 10(3): 159–182.

principle, transition management, and adaptation to climate change, introduced in Chapter 3.

Policy makers should also consider adopting LCA as a basic component of policy and investment analysis. In years to come, there is the potential for life-cycle considerations to be mainstreamed into economic development plans and poverty reduction strategies through an evolutionary process similar to the progressive improvements in environmental impact assessments over the past two decades.

A comprehensive strategic and policy approach to achieve greater resource efficiency must also take into account which aspects of increasing consumption are having the greatest impact on resource efficiency and target the reduction of consumption of those particular categories as part of an effective integrated plan. Such studies have been conducted in the EU (Box 4.1), but few Asian countries have taken this step.

One emerging national framework receiving attention is the PRC's circular economy. What sets it apart from recent efforts in other countries is that it is largely seen as an economic approach and is managed not under environmental protection agencies, but under the National Development and Reform Commission. The Circular Economy Law offers a long-term plan for transformation that seeks to integrate economic, environmental, and social strategies to achieve very high resource efficiency as a way of sustaining improvement in quality of life within natural and economic constraints.

The concept of the circular economy grew out of the realization that the development targets set by the Government would not be achieved unless alternative models of economic development were identified and applied. The Government recognized that continuing the present massive exploitation of natural resources and inefficient production practices could not continue. They will ultimately encounter resource starvation unless they are able to become much more efficient in their use of resources.

The initiative was developed as a part of the current 5-year economic and social development planning process. It provides a strategy for reducing the demand of its economy on natural resources, as well as the damage caused to natural environments. The Circular Economy Law is at the top of a hierarchy. A number of regulations and standards below the law will deal with specific issues. According to the legislation plan, some regulations and standards

Source: AFP.

will be put into act simultaneously with the Circular Economy Law.[101]

As of the end of 2007, the country's top lawmaking body, the Standing Committee of the National People's Congress, is in the process of drafting a law that will provide a legal framework to encourage and guarantee the development of the circular economy. Although the draft law is not available to the public at this stage, the major contents have been published. In the draft law, circular economy involves reducing, reusing, and recycling (3Rs) in production, consumption, and other life-cycle stages. New instruments, such as extended producer responsibility, environmentally friendly design, management of key enterprises, taxation, and investment and pricing measures will be adopted.

The basic approach is to integrate industrial firms, networks or chains of firms, eco-industrial parks, and regional infrastructure in a broad system to support resource optimization. State-owned and private enterprises, government and private infrastructure, and consumers will all play a role. There are three basic levels of action:

- At the individual firm level, managers must seek much higher efficiency through the 3Rs. Sustainable product and process design is important in German and Japanese recycling economy plans but is just emerging as a component of the PRC's circular economy concept.
- The second level is to reuse and recycle by-products within industrial parks and clustered or chained industries, so that they will circulate fully in the local production system.
- The third level is to integrate different production and consumption systems in a region so that the resources circulate among industries and urban systems. This level requires development of municipal or regional waste collection, storage, dismantling, reuse, and recycling systems.

Efforts at all three levels include development of resource recovery and cleaner production enterprises and public facilities to support realization of the circular economy concept. This adds a strong economic development dimension through investment in new ventures and job creation. The circular economy thereby opens opportunities for both domestic and foreign enterprises.

It is strategically important to recognize the economic benefits of the circular economy, as well as its costs. Market-based mechanisms are crucial to the success of this initiative. They enable the transformation to tap the creative entrepreneurial spirit of the new economy in the PRC while still using public planning mechanisms to assure balanced development. If the movement toward a more circular economy succeeds, PRC companies will be more competitive. PRC cities and development zones will develop new housing and commercial space in a more affordable way. Entrepreneurs will create new ventures, offering many new jobs. Households will enjoy improved quality of life.[102]

Targets, Monitoring, and Benchmarking

In formulating policies to improve resource efficiency, it is vital to quantify problems, set targets, and monitor progress toward achieving them through benchmarking. Environmental accounting practices, such as life-cycle analysis, full cost accounting, and resource accounting, are changing the way companies and nations perceive the relationship between the economy and the environment. These

[101] Comments from Xuejun Wang, Peking University, College of Environmental Sciences, 30 October 2007. Beijing, PRC.

[102] Indigo Development. 2005, July. *China Seeks to Develop a "Circular Economy."* Available: *www.indigodev.com/Circular1.html*

tools augment economic models and financial accounting systems that define environmental impacts as externalities and undervalue or ignore natural capital (resources and capacity to absorb industrial wastes).

In efforts to improve resource efficiency, whether on a national scale or on the factory floor, quantitative indicators can help indicate what needs to be changed and by how much; they also allow comparisons, either between governments or between companies; they are also important for measuring the progress of government and business actions against predefined targets.

Some useful quantitative indicators for assessing the sustainability of an operation are:[103]

- **Ratio of virgin materials to total material inputs in the production process.** This ratio could be used in assessing a product, production system, company, industry, or economy. The lower the relative draw on virgin materials (to replace materials lost from dissipation), the more sustainable the system.
- **Ratio of actual/potential recycled materials.** This ratio between volume of materials that could be recycled to the fraction actually recycled would also be useful at levels ranging from a production line to an economy.
- **Ratio of renewable/fossil fuel sources.** This ratio would tend to remain fairly stable for older plants but would be useful in designing new facilities, in reconstruction of plants, and at a corporate or industry level.
- **Materials productivity.** The economic output per unit of material input is a useful measure of resource efficiency.
- **Energy productivity.** The economic output per unit of energy input.
- **Waste disposal per economic output.** The economic output per unit of material disposed in dumps, landfills, incinerators, etc.
- **Resource input per unit of end-user service.** This ratio assesses resource use against the useful function gained and maintained for the end-user. The indicator addresses the concepts of product-life extension and the service economy (discussed on page 154).

Source: Kojima, Michikazu, Japan External Trade Organization (JETRO).

Such indicators should be built into various monitoring levels, ranging from firms, households, industries, sectors, to nationwide and, in some cases, regionally or even globally. On a macro level, sustainability indicators can be used to illustrate whether there is a decoupling of environmental impact and economic activity. Typically, GDP or GNP is chosen as the parameter representing the economic pillar, but the environmental aspects indicator is more complicated. Some have taken the approach of adding up all the environmental impacts caused by the various resource streams, an approach that requires a lot of data and is limited by imperfect measurements. Another approach is to focus on key resources. This method looks at the use of reserves of a few essential resources, typically energy, land, and biodiversity. The ecological footprint method, mentioned in Chapter 2, is based on this thinking.

Despite the difficulties in coming up with a reliable macro eco-efficiency indicator, many organizations think it is worth the effort. The World Business Council for Sustainable Development, for instance, proposes setting macroeconomic targets as sustainability conversion criteria in the form of eco-efficiency ratio indicators.[104] OECD, too, lists trends and targets of eco-efficiency ratio indicators, formulated as GDP per environmental influence. Recently, the World Bank developed a "green GDP"

[103] Ratios 1, 2, and 4 adapted from Ayres, Robert. U., and Udo Simonis. 1994. *Industrial Metabolism – Restructuring for Sustainable Development.* Tokyo: United Nations University Press. Available: www.unu.edu/unupress/unupbooks/80841e/80841E00.htm

[104] MacLean, Richard. 2000. Metrics Will Matter. *Air & Waste Management Association's Magazine for Environmental Managers.* (August): 11–13.

macroeconomic indicator, which is presented as the ratio of green GDP to the standard GDP. This environmentally adjusted GDP is being used in an experimental campaign to assess the performance of 10 cities and provinces in the PRC.[105]

Along the way, it is important that countries benchmark their progress compared to best practices in the region. Governments can provide support and incentives to research institutes and industry associations to research and establish benchmarks. This is often done on a sectoral basis. Sectoral benchmarking establishes reference points within an industry as to the use of process inputs and the generation of waste per unit of product by the most efficient producer in the sector, globally, regionally, or nationally. Other firms have reason thereby to believe that they too can become more efficient and have tangible targets toward which to strive. Benchmarking is particularly important for resource-intensive industries, such as steel, paper, cement and glass, and mass-produced consumer durables, such as automobiles.

Benchmarks can also be established to help measure the effectiveness of public policies and programmatic actions. National governments can use benchmarking to compare state or provincial government actions. These regional government units can in turn establish benchmarks for local or municipal governments.

The United Nations Environment Programme (UNEP) Regional Resource Centre for Asia and the Pacific recently released a sustainable development report for Asia that presented a number of national indicators that will allow policy makers to use benchmarks and assess trends in 30 different economic, social, and environmental areas. These included population level, standard of living, availability of clean water, percentage of forest cover, air pollutant emissions, and numbers of threatened species. Such indicators were geared toward assessing performance against the targets set in the MDGs.

These indicators show that the region is presently on an unsustainable development path. They exhibit progress in economic performance, poverty reduction, and human health, but declines in the quality of land, air, water, and biodiversity resources. Unfortunately, the indicator reports also show there is often a shortage of reliable scientific data on which to base assessments about environment and development progress. For this reason, the UNEP assessment is a useful starting point from which to improve monitoring and assessment capacity.[106]

Policy Instruments to Support Greater Resource Efficiency

Achieving resource efficiency requires careful planning and coordinated execution of both policies and programs. To be effective, reforms must target a set of producer and consumer behaviors to reduce society's overall use of resources, to minimize the generation of wastes, and to dispose properly of those wastes that cannot be avoided.

Policy and program instruments can be broadly described in five categories:

- **Regulatory instruments** specify an environmental goal or mandate or limit the use of a particular technology or process.
- **Economic** and **financial instruments** include a full range of direct and indirect incentives to help reduce the costs of resource-efficient investments and/or reduce barriers to and costs of commercial financing.
- **Information-based instruments** stimulate the adoption of appropriate practices through information measures, such as public awareness campaigns, public disclosure of firms' environmental performance, and ecolabeling schemes.
- **Voluntary initiatives** take the form of partnerships between governments and the private sector to develop co-regulatory policy systems (where there is a high level of interaction between the parties, but the agreed standards are not mandatory) or self-regulatory policy systems (where industry acts unilaterally in setting standards that are not legally enforceable).

[105] Chan, Florence. 2005, 16 March. The State of Pollution. *Asia Times Online.* Available: http://www.atimes.com/atimes/China/GC16Ad01.html

[106] The New Nation. 2004,17 November. *Sustainable Development in Asia: UNEP Report Released.* Available: http://nation.ittefaq.com/artman/exec/view.cgi/24/13856

An optimal mix of environmental policy instruments will often include all four of these categories. Decision makers must carefully evaluate and select each policy instrument to be appropriate to the objective and to the setting. To accomplish this, they need to consider the present constraints to change, the resources supporting change, and the conditions that must be established to allow for change. Some considerations include the following:

- **Political.** To what degree will the existing political regime support the initiative with resources, enforcement of regulations, relevant enabling policy, and public visibility?
- **Economic.** Does the government have the financial resources to undertake the proposed initiatives and how can they support exports and trade?
- **Technological.** Are there the technically skilled domestic personnel necessary to maintain and support the technologies needed?
- **Financial.** Can the initiative be undertaken without harming the industry's profitability and competitiveness in any way? For public facilities and operations, is there budgetary authority to implement the change or does it require aid funding?
- **Infrastructure.** If the technologies or procedures involved in the initiative require new access to water, electricity, transport, etc., does the needed infrastructure exist? If not, what are the likely costs to add it?
- **Regulatory.** Are there enforceable environmental and fiscal regulations that support resource efficiency? Are staff available for enforcement?
- **Legal**. Is there an effective system of civil and criminal law to provide due process in enforcing the regulatory regime?
- **Institutional.** Are there institutions (academic, NGO, business, etc.) capable of implementing and monitoring an initiative for greater resource efficiency?
- **Business.** Are the candidate businesses sufficiently advanced and organized to be able to keep records, monitor their progress, and otherwise try to improve their resource efficiency?
- **Banking.** Is credit available and accessible, especially to SMEs, to invest in resource-efficient improvements in production?
- **Social.** Will the initiative conflict with and meet resistance from prevailing social values or otherwise negatively affect the social conditions of the people involved?
- **Land.** Are land-use patterns and regulation, transportation design, and land-use planning sufficient to support land-related initiatives?

The combined answers to these questions will indicate whether the particular instrument under consideration is appropriate for use in the sector and by the agency concerned, and if it will fit within a larger national effort to mainstream resource efficiency in public policy and programs.

Regulatory Instruments

Regulatory instruments specify an environmental goal or mandate or limit the use of a particular technology or process. Since the inception of environmental policy, the predominant strategy for pollution reduction has been through the use of regulatory instruments. In industrialized countries, regulatory programs are the foundation on which environmental quality has been built. These countries have relied mainly, though not exclusively, on what is known as specified compliance—precise and specific demands that have been imposed on the regulated communities, with little bargaining allowed and few exceptions made. Typically, a public authority sets standards and then inspects, monitors, and enforces compliance to these standards, punishing violations with formal legal sanction.

Source: AFP.

These regulations may specify an environmental goal, such as the reduction of carbon dioxide emissions by a specified date, or they may mandate or limit the use of a particular technology or process. Such an approach gives the regulator maximum authority to control where and how resources will be allocated to achieve environmental objectives, and it provides the regulator with a reasonable degree of predictability as to how much the pollution levels will be reduced.

This somewhat authoritarian style of government has undoubtedly been successful in improving environmental conditions. There are many situations where regulatory instruments may be the most appropriate and effective means of achieving a desired outcome, examples being the control of hazardous materials through specified restrictions or banning.

However, it should be noted that regulatory instruments also have significant drawbacks. The regulated community tends to become alienated and united in its opposition to the rule makers, and the approach has tended to encourage the use of end-of-pipe, media-specific technologies to respond to the regulatory requirement in a direct and visible manner. It has, therefore, had only limited success in reducing wastes through the redesign of products or increased efficiency of production processes.

Experience in the US and Europe has also shown that the command-and-control approaches are associated with high administrative costs and relatively low economic efficiency. Thus, rather than relying solely on policies that dictate actual technologies and acceptable levels, governments should employ economic and financial measures to complement their regulatory regimes.

Economic and Financial Instruments

Economic and financial Instruments can help encourage corporate innovation to meet pollution and natural resource management standards and can also affect investment decisions by reducing the overall costs of resource efficient investments or by reducing barriers to and costs of commercial financing. Options include a full range of direct and indirect economic incentives (and disincentives) to improve resource efficiency, including

- establishing market-based prices for all commodities;
- setting prices for utility energy and services on a quota basis, increasing costs for excess consumption rather than lowering them for high volume use;
- providing financial and social incentives to companies that excel in resource efficiency. These may include tax breaks, preference in government procurement, and recognition programs;
- assessing taxes, duties, or fees to promote efficient practices by raising the costs of unwanted outputs or by providing incentives to promote more efficient use of natural resources (Box 4.2);
- offering incentives and promotional programs for private investment institutions, encouraging them to make loans for facility retrofitting and high-performance design of new buildings and facilities;
- creating revolving loan funds (as public private partnerships) to support the same types of loans, particularly for SMEs;
- creating property rights and helping to establish a proxy market (for example by using tradable pollution permits);
- ending subsidies for resource extraction and use, such as preferential water pricing for large users; and
- reforming economic measures, such as GDP, to debit the costs of pollution, impacts on health, and waste.

For such financial and economic instruments to be applied successfully, effective administrative, monitoring, and enforcement capacities must be in place. Such measures should only be developed as part of an integrated policy approach that addresses barriers in industry and the financial sector and must be tailored to the specific conditions in the country. In the energy sector, for instance, they are effective when implemented along with compulsory audit schemes, energy performance standards, training programs, promotion campaigns, and research and development support.

In addition, before introducing any financial or market-based measures, governments should identify

Box 4.2: Environmental Taxation

Environmental taxes (or charges) may operate within the discharge limitations to make the polluting firm pay for the discharges from its facility, even though they may be within the regulatory limitations. Placing a cost on the discharge of wastes creates an incentive for the producer to become more efficient, reducing intensity of resource use and of environmental impact. The charges should be on a mass rather than a volume basis to make the charge relative to the toxicity of the discharge. They should also be on an escalating scale per unit of discharge, increasing with discharge per unit of product to provide a strong incentive for the producer to reduce the intensities of its production. In some instances, it may be appropriate for the revenues from these instruments to be used to support relevant activities and further stimulate preventative approaches.

A significant constraint against the more widespread adoption of environmental taxes is that it is often not politically feasible to set taxes at a sufficiently high level to achieve desired environmental goals. Governments often face resistance if taxation related to environment is taken merely as a means of increasing its revenues. It may be able to avoid some obstacles by earmarking the corrected charges or shifting tax sources. Further, the successful implementation of such instruments requires a system of monitoring, revenue collection, and enforcement, as well as measures to combat possible corruption.

Source: UNEP. Available: www.uneptie.org/pc/cp/understanding_cp/cp_policies.htm

and evaluate any economic incentives already in operation, either explicitly or implicitly. These include, for example, subsidies that have been offered in an attempt to make local industries more competitive. Subsidies can apply to particular inputs to production (e.g., carbon-based energy) or to the import of used equipment or outdated and inefficient technology. They often alter the resource selection decisions and mask environmental externalities and do not lead to either the best business or environmental outcomes. Thus, government assessments of such policies are needed before other economic instruments are applied.

Information-Based Measures

"Restructuring a system doesn't mean shoving people or things around, bulldozing, rebuilding, hiring, firing — that's not what changes system behavior. Almost always, the most effective restructuring means putting information into a place where it doesn't now reach, or changing goals, rewards, incentives and disincentives, so that the same people, in the same positions, make decisions a different way. Restructuring a system means changing what's in people's heads." Donella Meadows, co-author, Beyond the Limits to Growth.

Although both production and consumption are rising in the region, the awareness of citizens, corporations, and governments concerning resource and waste issues is still low. Consumption is the ultimate driver of production, and thereby of the impacts of the goods and services produced. In rapidly developing Asia, the changing patterns of consumption play a key role in determining the efficiency or inefficiency of use of resources. To ignore the patterns of consumption and their interactions would be to disregard the underlying forces driving the use of resources and the directions in which those uses are evolving. Problematically, evidence is mounting that resource-efficiency improvements are being outpaced by increases in overall consumption levels around the world.

Thus, in addition to appropriate regulatory and financial frameworks for resource efficiency, public awareness and stakeholder involvement are essential to make resource-efficiency efforts work and to overcome resistance to change. Governments can further stimulate the adoption of appropriate practices through information measures. Action can be taken in a variety of areas to increase environmental awareness and education. Some of these include public awareness raising campaigns, incorporation of environmental issues in mainstream education, use of the media, increasing awareness and education in target groups and encouragement of public participation in environmental matters. There is also a set of informational measures that can target industries, including ecolabeling schemes, public disclosure of firms' environmental performance, energy audits, environmental accounting systems, and capacity-building programs. These are discussed in Chapter 9.

However, information alone is not enough to advance sustainable consumption patterns. Consumers are clearly more environmentally and socially aware today than previously, but they still do not generally consume with concern.[107] In the minds of most consumers, social concerns are secondary to price, quality, and style. Similarly, although producers occasionally herald a new green design or "win-win" pollution prevention option, they continue to profit from the "throwaway" cultural mentality. The lifespan of many products, such as electronics equipment, is decreasing due largely to rapid and continual improvements in technology.

The important point is that public awareness campaigns must endeavor to not only raise awareness, but also change attitudes and actual behavior. If done effectively, these efforts can affect a population's willingness to cooperate and participate in local programs, such as segregating waste to assist recycling activities, paying for waste management services, and participating in water or energy conservation efforts.

In the recent UNEP publication on public campaigns, *Communicating Sustainability*, the objectives of communication campaigns are summarized as follows:

1. **Raise awareness,** i.e., improve people's knowledge of an issue or creating new knowledge. If what we are really seeking is public engagement for sustainable development, then attitude and behavior change are often more appropriate targets.
2. **Change attitudes,** i.e., change the way people think and feel about an issue. While attitude change can be a precursor to behavior change, it does not guarantee it. Attitude change does, however, have an important role to play in preparing for new policy initiatives. It can help to ensure compliance with new legislation, such as the compulsory wearing of seatbelts.

Source: AFP.

3. **Change behavior,** i.e., influence people's actions relating to an issue. This is where efforts should be concentrated if we are to reach our sustainable development goals. However, it is a long-term approach, sometimes taking an entire generation to come into effect.[108]

Educational and awareness efforts can target specific sectors of society or can seek to raise public awareness broadly on environmental issues. Table 4.1 summarizes three categories of public awareness and education—sustainable environmental education, targeted campaigns, and broad public awareness campaigns.

Many sectors of society can be involved in developing and delivering educational courses and public awareness campaigns: governmental institutions at the national, regional, and local levels; domestic and international NGOs; primary, secondary, and postsecondary schools; and journalists and the media. Funding for awareness and education initiatives may come from a variety of sources, such as from the budgets of specific agencies or ministries or from national environment funds.[109]

Voluntary Initiatives

With the growing appreciation of the limits of conventional policy instruments, many governments are encouraging the adoption of voluntary self-regulatory and co-regulatory policy instruments. The

[107] O'Rourke, Dara. 2005. Market Movements: Nongovernmental Organization Strategies to Influence Global Production and Consumption. *Journal of Industrial Ecology* 9(1–2). Massachusetts Institute of Technology and Yale University. Available: http://www.mitpressjournals.org/doi/pdf/10.1162/1088198054084608

[108] UNEP and Futerra. 2005. *Communicating Sustainability: Howe to produce effective public campaigns*. Available: http://www.uneptie.org/pc/sustain/reports/advertising/Communication_Guide/webEN2.pdf

[109] UNEP. 2002. *Online Manual on Compliance with and Enforcement of Multilateral Environmental Agreements*. Available: http://www.unep.org/DEC/OnLineManual/Enforcement/InstitutionalFrameworks/PublicAwarenessEducation/tabid/99/Default.aspx

Table 4.1: Types of Public Awareness and Education

Type	Description	Example in the Region
Sustainable Environmental Education	"Sustainable environmental education" is defined as a continuous process of education, training, and personal development that seeks to form the system of scientific and practical knowledge, skills, values, behavior, and activities in the fields of environmental protection, sustainable environmental use and consumption, and education. There are six stages of sustainable environmental education: (i) pre-school; (ii) primary schools; (iii) secondary professional schools; (iv) institutes of higher education; (v) advanced training of state employees, production specialists, and personnel of different establishments and governing bodies; and (v) the public sector.	In the Kyrgyz Republic, leading environmental experts from the institutes of higher education, Ministry of Environment, Ministry of Education, and nongovernment organizations have developed the concept of sustainable environmental education. Under the project, an assessment and expert evaluation was performed on state educational standards of higher environmental education for masters' and diploma specialist degrees. An interdepartmental expert committee has obtained approval of new state educational standards, as well as implementation of the sustainable environmental education concept.
Targeted Campaigns	Often, it is not necessary to communicate the entire concept of sustainable development to bring about change. It may be more effective to focus on a single issue, such as energy efficiency or buying ethical products. Different audiences, both across countries and within a specific country, will respond to different tones of voice or different media. For this reason, it is important to word messages and choose communication channels carefully. The most successful communications campaigns tend to be the ones that tightly define their target audiences.	In Viet Nam, despite the emergence of new ways to control pests, farmer training programs, and stricter policies on insecticide use, many farmers continued to overuse insecticides in the mid-1990s. To address the problem, a pesticide reduction campaign was introduced to encourage large-scale reductions in pesticide use by rice farmers on the Mekong Delta and to increase awareness among farmers of pesticide-related issues, such as health and environmental problems. By 1997, the campaign, along with similar campaigns, had reached 92% of the 2.3 million households living on the Mekong Delta. During that time, provincial governments distributed 340,000 leaflets and 35,000 posters, organized 1,390 demonstration plots, and broadcast a comedy series over the radio about 1,550 times. The radio campaign was developed into a long-running drama series. The advantage of using drama was that listeners or viewers could identify with characters that act as role models for their own lives. The success of the campaign in changing the practices of farmers and the wide uptake of the campaign by provincial governments helped convince the national government to alter some of its policies on pesticide use.
Broad Public Awareness Campaigns	Campaigns that seek to change behavior across a wide segment of society need to have a firm grasp of what motivates an audience and must then translate that into messages that are both personal to the audience and practical in terms of inspiring a response.	New Zealand's Big Clean Up campaign was launched in 2002 to encourage Auckland householders to live more sustainably by increasing understanding of environmental issues and providing simple actions they could take to reduce their impact on the environment. It offered environmental "health checks" for individual households and followed them up with personalized action plans. Behavior change was sought in three ways: mass advertising campaigns, a membership program of over 40,000 households, and school programs. The target of signing up 30,000 people was reached just 8 weeks after the launch. It has been used as a model for many local and central government programs. Its waste campaign went national in a collaborative campaign involving over 30 agencies.

Source: United Nations Environment Programme and Futerra. 2005. *Communicating Sustainability: How to Produce Effective Public Campaigns*. Available: http://www.uneptie.org/pc/sustain/reports/advertising/Communication_Guide/webEN2.pdf basic concept of voluntary initiatives is that more can be accomplished through a negotiated partnership than through enforcement of regulation alone.

Most voluntary programs take the form of partnerships between governments and the private sector. They come in an infinite variety of forms and include any relationship in which the government and a firm or business sector agree to mutually beneficial terms and as a result, the behavior of the firm changes toward greater resource efficiency. Different types of voluntary initiatives are discussed in Chapter 9.

National Policies to Support Materials, Energy, and Water Efficiency

While countries should consider following the example set by the PRC to develop an integrated policy to promote resource efficiency, it is also important to establish sound policies that separately determine resource efficiencies of materials, energy, and water, using the policy instruments discussed above. This section discusses these three sectors separately because the policy and technological responses in each of the three sectors have been very different and have been historically separated along these lines, both conceptually and institutionally.

It is important to note that not all programmatic approaches or policy tools are appropriate in all cultures and economic conditions. Some may be irrelevant in a particular economy at a particular point in its political or economic development. Some may be inappropriate in a particular culture or within certain business practices or value systems. For instance, certain measures, such as DSM in the energy sector, require structural reforms before they can be implemented. Thus, the level of policy sophistication can be loosely tied to a country's level of development. However, countries should not wait until they reach a certain level of development before they develop and implement important policy measures. Countries can pursue many measures regardless of present constraints. These ideas are reflected in Table 4.2.

Some decision makers may be reluctant to put in place new market-based or regulatory measures because of concerns that they will hurt business or cause the loss of jobs. However, the indications are that enormous business opportunities will be created once more effective policies are in place. More systematic attention to waste management and resource-use efficiency translates into new jobs and new business opportunities.

Policies to Promote Materials Efficiency

In a number of Asian countries, national and local government leaders are developing and implementing upstream and downstream measures to deal more effectively with the enormity of their waste problems. On the downstream side, some countries are pursuing integrated waste management, which incorporates such practices as source separation and waste recovery. On the upstream side, new laws promote design-for-environment (DfE), which involves enhancing the design of a product to reduce environmental impacts and resource consumption. Other laws include green purchasing regulations or promotion of extended producer responsibility (EPR) through take-back provisions, whereby producers are required to take steps to make it easier to take back their products for recycling. Other measures are helping to promote a better public understanding of the environmental consequences of the "consumer society" and to bring about shifts in purchasing behavior and lifestyle choices.

The 3R Knowledge Hub (Box 10.1) undertook research aimed at presenting the prevailing technology, management, and policy gaps in implementing the 3Rs in waste management in selected Asian countries. For each country, a number of different 3R management aspects were rated as sufficient, insufficient, or as policy gaps (Table 4.3). For their assessment, countries were grouped into three categories based on their best available waste disposal technologies, relevant policy measures, and enforcing regulations as follows:

1. Japan, Republic of Korea, and Singapore form the group of developed Asian countries with good practices of waste management in terms of implementation efforts, policies, and relevant legislations.
2. Bangladesh, PRC, India, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam form the group of developing Asian countries systematically planning to achieve better waste

Table 4.2: Policy Measures to Improve Resource Efficiency

Area of Resource Management	All Countries	Least-Developed Countries	Middle-Income Developing Countries
Materials Efficiency	• View wastes as valuable resources that can contribute to jobs and economic opportunity. • Use market signals to shape solid waste management behavior of both producers and consumers. • Develop a general law on waste management, which, among other things, should introduce a general policy framework, define and classify wastes, establish roles for the public and private sectors and the responsibility of polluters, regulate proper disposal, and set technical standards. • Practice integrated solid waste management. In addition to upgrading solid waste disposal sites, give equal attention to upstream options to reduce waste for final disposal and to reuse and recycle valuable resources. • Take advantage of expanding global carbon markets through waste-to-energy schemes, biomass generation of energy, and methane capture systems. • Promote a thriving resource recover and recycling industry, including core resource recovery businesses, manufacturing firms, and wholesale and retail businesses.	• Focus on opportunities to capture higher benefits from recovering biomass, which accounts for the greatest share of the waste stream in least-developed countries. Evaluate the relative costs and value derived from competing uses—composting, animal feed, and generation of bioenergy. • Avoid high-cost and energy-intensive technologies that may not be appropriate for local conditions. • Improve working conditions and minimize work-related toxic exposure at collection, dismantling, recovery, and disposal facilities. • Take measures to limit illegal import of hazardous waste, including by tracking shipments and controlling shipments of secondhand goods.	• As waste diversifies, develop specific laws and regulations, as well as guidelines and manuals for specific wastes, including container and packaging, electric household appliances, construction materials, and end-of-life vehicles. These can incorporate bans on certain substances or take-back provisions. • As waste management becomes more costly and complicated, establish financial mechanisms and strategies to create a more sustainable base for waste management. • In moving from informal to more formal waste management arrangements, consider the contribution of informal waste collectors and resellers. • More advanced disposal systems are needed to handle the higher volume and diversification of waste, including modern landfills with advanced systems that can treat leachate and recover landfill gas, and state-of-the-art incinerators that satisfy stringent environmental parameters. • However, do not rely too heavily on conventional solutions. Options like composting and processing for chemicals recovery may offer higher value than incineration, even with the capture and use of the energy.
Energy Efficiency	• Ensure market-based pricing of fuels and energy sources. • Recognize that new approaches to the efficient use of energy resources are needed as part of an energy policy.	• Understand that infrastructure investments can lock in energy efficiency levels for decades, so do not wait until a certain development level is reached to institute energy efficiency measures.	• Develop energy service companies and develop special local bank lending arrangements to provide energy conservation financing. • Promote carbon projects utilizing the Clean Development Mechanism to help promote technological improvement.

Continued on next page

Table 4.2 continued

Area of Resource Management	All Countries	Least-Developed Countries	Middle-Income Developing Countries
	• Develop and adopt laws, ordinances, and regulations that use a mix of regulatory, market-based, and voluntary measures to encourage adoption of greater energy efficiency and energy conservation technologies and practices. • Consider combining energy efficiency policies with national programs for reducing greenhouse gas emissions and promoting renewable energy. • Recognize that government is a major user of energy, designing and managing all public assets and operations for high energy performance both for direct gains as well as to set norms for private action.	• Reduce energy subsidies to encourage more efficient use. • Develop and promote high performance energy-efficient design standards and/or codes (for buildings, appliances, and vehicles). • Develop renewable energy policies and strategies, including promotion of distributed renewable energy systems. • Promote intermodal transportation planning. • Develop and promote cleaner vehicle technologies and alternative fuels.	• Once necessary incentives are in place, develop and adopt frameworks for demand-side management, including residential demand management programs and initiatives to accelerate utilization of energy-efficient lighting and appliances in households. • Develop policies and programs that promote net metering, which allows a two-way flow of electricity between the distribution grid and customers with self-generation.
Water Efficiency	• Practice integrated water resources management (IWRM): o Develop the information required to make strategic choices (i.e., comprehensive water assessments). o Improve allocative efficiency at local, national, and regional levels—allocating water to its highest valued uses whenever feasible (while recognizing the special characteristics of water as a basic human need). o Provide an enabling environment to improve efficiency at local levels (both technical and economic efficiencies). o Link local to regional and national plans. o Reduce pollution discharges to water bodies through appropriate policy and technology solutions. • Introduce and administer realistic water prices to encourage efficient use of water.	• Since agriculture is a major consumer of water resources in most least-developed countries, efforts need to be concentrated here. • Increase agricultural yields per unit water by practicing conjunctive water management, improving conveyance and application efficiency, and improving productivity in rainfed areas. • Reduce nonrevenue water in urban areas by addressing leaks, illegal connections, and metering problems. • Promote ecosanitation systems that collect and recycle urine and feces separately as organic fertilizer and conserve the use of water.	• Promote domestic conservation efforts, such as through toilet or shower retrofitting. • Develop demand management policies and utilize water user associations to undertake irrigation scheduling or implement best farm management practices. • Develop more capital-intensive systems, such as large-scale wastewater reuse schemes and desalinization. • Help promote water markets to create incentives for farmers and/or industries to save water and sell off their rights to the portions they do not use. This requires well-defined, tradable and enforceable water rights, a strong regulatory framework, and the infrastructure necessary to transfer water from one user to another.

Source: Compiled by the Asian Development Bank from various sources.

Table 4.3: Current Situation of National Policies, Legislative Measures, and Other Initiatives in Promoting the 3Rs in Waste Management

3R Management Aspects		Countries												
		Bangladesh	Bhutan	Cambodia	PRC	India	Indonesia	Japan	Malaysia	Philippines	Republic of Korea	Singapore	Thailand	Viet Nam
Systems for Integrating Environmental Considerations into Socioeconomic Activities	Framework	○	◊	○	○	○	○	●	○	○	○	○	○	○
	Direct Regulatory	○	○	○	○	○	○	●	○	○	●	●	○	○
	Economic	◊	◊	○	○	○	○	○	◊	○	○	○	○	○
	Voluntary	○	◊	N.I.	○	○	●	○	○	●	○	○	○	○
	Information	○	●	◊	○	◊	○	○	○	◊	○	○	○	○
	Procedural	○	◊	◊	◊	◊	◊	○	◊	◊	○	◊	◊	○
Support for 3R-related Activities		○	○	●	○	◊	○	○	○	○	○	○	○	●
Environmental Education		◊	◊	◊	○	◊	●	○	◊	◊	◊	◊	◊	◊
Science and Technology		○	◊	○	○	○	○	●	◊	◊	○	○	◊	○
Reduction of Barriers to International Flow		○	○	○	○	○	●	○	○	○	○	○	○	●
International Cooperation		○	○	○	●	○	●	●	○	○	○	○	●	●
Cooperation of Stakeholders		○	◊	●	◊	◊	●	○	○	●	◊	○	○	○
Promotion of Science and Technology		N.I.	○	◊	○	◊	○	○	○	○	○	○	○	○

● – Sufficient: for example, in the Philippines, the reported voluntary initiatives were found to be sufficient to affect the shift toward the 3Rs.

○ – Insufficient: denotes that the particular aspect partially addresses 3Rs, but may not be enough to initiate 3R-oriented activities. In Malaysia, for example, the prevailing management measures were found to be inadequate to implement 3Rs.

◊ - Gap: denotes a missing aspect that is considered essential to initiate 3R-oriented activities.

3Rs = reduce, reuse, recycle; N.I. = No information; PRC = People's Republic of China.

Source: 3R Knowledge Hub Secretariat. 2007. *Gap Analysis in Selected Asian Countries*. Bangkok: Asian Institute of Technology.

management through progressive policies and plans.

3. Bhutan and Cambodia are aspiring nations looking forward for proactive policies and waste management measures.[110]

The Government of Japan has embarked on a full-scale effort to improve efficiency of material use by promoting the 3Rs. As part of a system-wide policy development effort, Japan has adopted laws that constitute the country's system of legal and voluntary 3R initiatives. In May 2000, the Japanese legislature passed several laws, the most important of which was the Fundamental Law for Establishing a Sound Material-Cycle Society. This law establishes the basic principles for the creation of a recycle-oriented society, and the plan for achieving it. Built on two earlier pieces of legislation that dealt with recycling and waste disposal in general, this law is the first "framework law" setting forth requirements for, among other things, the move toward a recycling-based approach to product design, manufacture, use, and disposal by various segments of Japanese society.[111]

The law also sets quantitative national targets (fiscal years 2000–2010) as follows:

- Resource productivity (GDP/direct material input): 40% improvement
- Cyclical use rate (total used and recycled material input/material input): 40% improvement
- Amount of final disposal: 50% improvement

In addition, several recent laws set up targeted recycling regimes. These include laws on containers and packaging, electric household appliances, construction materials, food, end-of-life vehicles, and

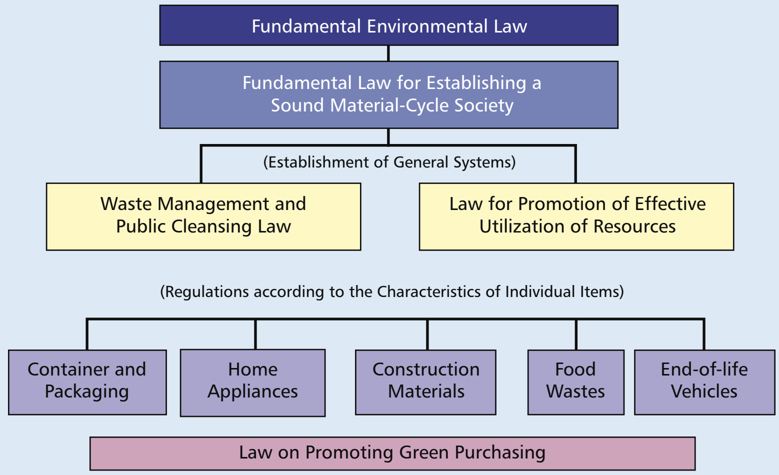
[110] Visvanathan, C. 2004. *Municipal Solid Waste Management in Asia*. Asian Regional Research Program on Environmental Technology and Swedish International Development Cooperation Agency. Bangkok: AIT.

[111] EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1

green procurement. In some cases, these laws are supported by economic instruments. For instance, to help step up efforts to recycle cars and prevent dumping them illegally, Japan requires manufacturers to charge owners for recycling their vehicles. The purchase price of a new car will include the recycling cost, while existing car owners will be charged at their next mandatory vehicle inspection.[112]

Together, the framework law and individual product laws (Figure 4.1) have paved the way for Japan to take a holistic approach that includes a wide-range of product stewardship measures, including product take-back and recycling, restriction of substances, EE requirements, and packaging and labeling requirements.

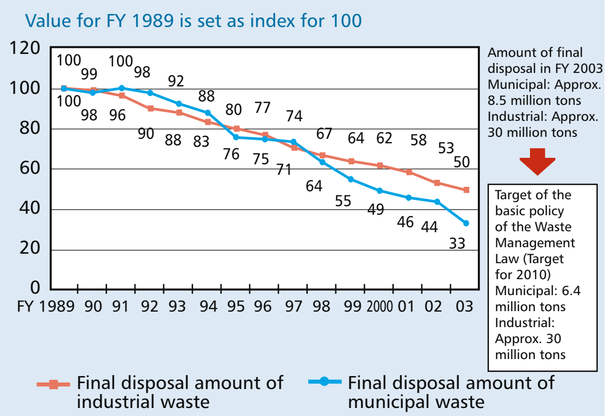
Figure 4.1: Legislative Framework for a Sound Material-Cycle Society in Japan



Source: Ministry of the Environment, Japan.

Largely as a result of this legislation, Japan was able to reduce drastically the amount of municipal and industrial waste for final disposal (Figure 4.2). After the introduction of these product-oriented recycling acts, the amount of domestic solid waste for final disposal in 2003 dropped to half of that in 1989, while industrial solid waste was reduced 67% over the same period. In addition, the export of recyclables from Japan increased exponentially from 1990 to 2004 (see Chapter 10 for more detail on the international trade of recyclables).

Figure 4.2: Changes in Amount of Final Disposal in Japan (1989–2003)



FY = Fiscal Year.

Source: Ministry of the Environment, Japan.

The Republic of Korea is another success story in the region. In March 2002, the country prepared a national framework under the Second Comprehensive National Waste Management Plan (2002–2011) to establish a sustainable and resource circulating socioeconomic foundation, thus leading to the consistent promotion of waste reduction policies. The targets under the plan are to

- reduce municipal waste generation by 12%, which is expected to reach about 52,000 tons/day in 2011;
- reduce the amount of waste incinerated or dumped in landfills by 22% from 28,000 tons/day in 2002 to 21,000 tons/day in 2011;
- increase recycling by 53% by 2011 through such efforts as direct investment of 1.3 trillion won (W) ($1=W930) for expanding recycling facilities, developing recycling technologies, and fostering the recycling industry;
- reduce industrial waste generation by 8%, while increasing industrial waste recycling to 80%; and
- reduce per capita household waste generation from 1.04 to 0.94 kilograms and increasing the household aste recycling rate from 44% to 50% between 2002 and 2008.[113]

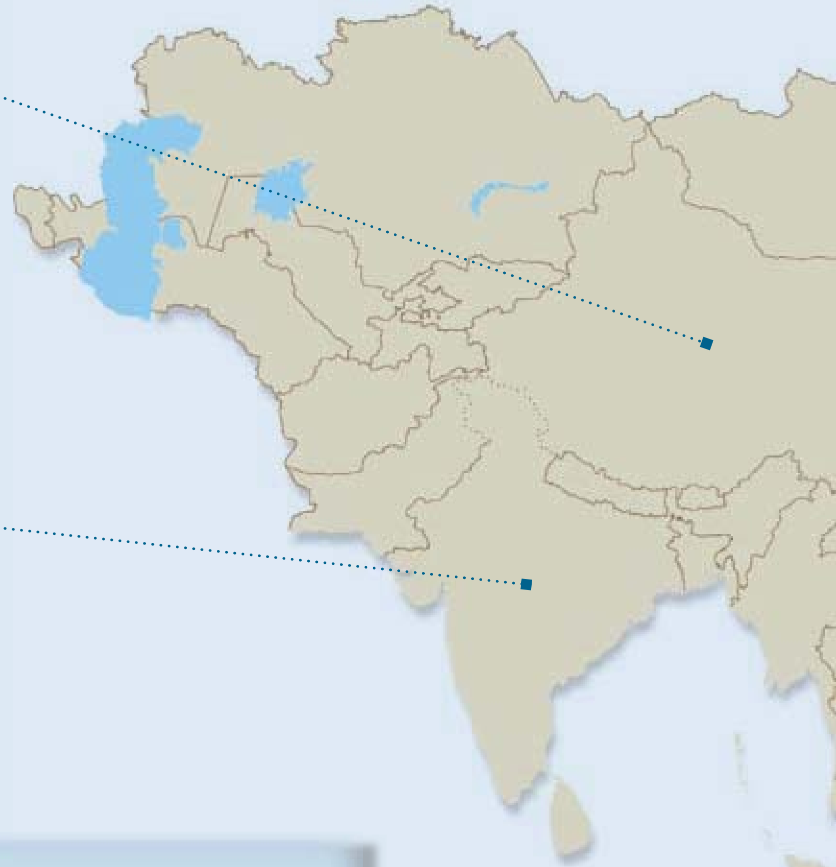
112 *Recycling Today*. 2004, 29 Dec. Japan Set to Start Vehicle Recycling Law. Available: http://www.recyclingtoday.com/news/news.asp?ID=6948

113 3R Knowledge Hub Secretariat. 2007. *Gap Analysis in Selected Asian Countries*. Bangkok: AIT..

Figure 4.3: Policies to Enhance Material Efficiency and Sound Disposal in Selected Asian Countries

People's Republic of China: A number of product-related environmental laws are being developed that would provide the regulatory bases for additional product specific measures. These will include substance restrictions in electronic products and take-back and recycling measures for electronic products.

India: The Municipal Solid Waste Management Rules passed in 2000 oblige municipalities to introduce household segregation of organic and non-organic waste and to treat the organic fraction by composting or other appropriate means. However, in many cities, implementation has been slow.



Malaysia: The National Environmental Policy 2002 guides all programs toward Integrated Waste Management and Malaysia's National Solid Waste Action Plan was passed in 2003.

Note: Boundaries are not necessarily authoritative.

3Rs = reduce, reuse, recycle.

Source: Asia 3R Conference. 2006. Chair's Summary. Asia 3R Conference, 30 October–1 November, Tokyo. Available: http://www.env.go.jp/press/file_view.php?serial=8677&hou_id=7655

Japan: A Framework Law sets forth requirements for the move toward a recycling-based approach to product design, manufacture, use, and disposal. Several recent laws also target specific items or materials, such as packaging, appliances, and construction materials. As a result of this legislation and financial measures, the amount of domestic solid waste for final disposal in 2003 dropped to half the amount disposed in 1989, while industrial solid waste was reduced 33% over the same period.

Thailand: The Government has developed a national integrated waste management plan. Many relevant projects are being implemented, including government green procurement, a waste exchange program with over 400 industries currently registered, and tax incentives to encourage the recycling of lead-acid batteries at a rate of 84%. Through the green manufacturing program and e-waste management, technology and knowledge transfer relating to 3Rs and eco-design has been initiated in cooperation with other countries.

Philippines: Lawmakers passed the Ecological Solid Waste Management Act in 2000, which mandates management for "zero waste" as a national policy and requires local government units to recycle 25% of waste collected.

Singapore: The Singapore Green Plan 2012 sets a "zero landfill" objective for the longer term. It includes a national waste recycling program, with a target of 60 % recycling by 2012.

Along with a volume-based waste fee system introduced in 1995, this framework will help the country to further decouple the generation of municipal waste from private final consumption Nearly three quarters of all municipal and industrial waste was recycled in 2003, a rate that is one of the highest among OECD countries and that exceeds its own Green Vision 21 target.

Following the examples of Japan and the Republic of Korea, many countries in the region will continue to improve their material efficiency-related policies. However, while many countries have recently passed important legislation that promote improved material resource efficiency (Figure 4.3), laws are still outmoded and fragmented and policies are not consistently implemented. In India, for instance, despite the creation of recent waste-management related acts, the primary method of waste disposal is still open dumping and there is little waste segregation practiced throughout the country.[114] This suggests a need to better develop capacity in monitoring and enforcement of regulations in India and other Asian countries.

In most countries in the region, there is also a great need for human financial and technical resources for waste management. While the "polluter pays" principle is known around the region, implementing such policies has been a different matter. Governments should create conditions that will shape behavior through appropriate pricing and make investments attractive to private capital for waste reduction, reuse, recycling, and disposal of residual materials. The public, including most waste generators, expect the bulk of capital, operating, and maintenance expenditures for waste management to be borne by the government.[115] Financial mechanisms and strategies in the region to establish a more sustainable base for waste management clearly need to be analyzed and changed. There are also increasing opportunities to take advantage of expanding global carbon markets to support waste-to-energy schemes, biomass generation of energy, and methane capture systems.

While solid waste management is usually a function of local authorities, these efforts will require cooperation from the community level all the way to the international level. As shown by the more developed countries in the region, there is a need for a broad range of laws to promote efficiency in materials use. These include a general law on waste management, which, among other things should introduce a general policy framework, define and classify wastes, establish roles for the public and private sectors and the responsibility of polluters, regulate proper disposal, and set technical standards. Specific laws and regulations, as well as guidelines and manuals, for specific wastes are needed. General rules are not enough for some kinds of wastes and processes, such as medical and hazardous wastes. Private sector investment in new industries and technology development needs to be encouraged.

Similar to Japan's Basic Law to Encourage the Development of a Recycling-Oriented Society, new policies will increasingly address the entire life cycle of products. At the resource and extraction phase, policy instruments will include raw materials taxes and licensing agreements. At the production and consumption phase, they will include integrated product policy, quotas for recycled inputs, and clean technologies. And at the waste management stage, they will include landfill and pollution taxes and technical standards. Some of the more prominent policy measures that countries in the region will increasingly implement are presented below.

Substance, Product, or Technology Bans

As noted, many countries in Asia are beginning to address resource efficiency not only through overarching legislation, but also through separate laws that apply to specific products. For each of these laws, it is necessary to set recycling targets, as well as roles and cost sharing among relevant parties. A number of these laws include DfE considerations, which involve reducing environmental impact and resource consumption by improving product design. DfE is a key component of integrated product policy, which is a policy concept advanced by the EU to minimize environmental impacts at all phases of a product's life cycle.[116]

DfE-based policies often take the form of substance, product, or technology bans, which is an authoritarian means of promoting environmentally sustainable practices by imposing a ban or a defined

114 Ibid.
115 Ibid.
116 EU Integrated Product Policy. Available: http://ec.europa.eu/environment/ipp/

Box 4.3: Restrictions on Hazardous Substances in the PRC

The European Union (EU) accounted for a quarter of the $200 billion worth of electronics exports from the People's Republic of China (PRC) in 2004, Thus, the PRC decided to synchronize the implementation of its laws with an EU deadline on restrictions on hazardous substances (RoHS). In February 2006, the PRC's Ministry of Information Industry, together with another six central government agencies, promulgated Management Methods for Controlling Pollution by Electronic Information Products. The PRC's version of the RoHS restrictions is imposed on the design and development of products, raw materials procurement, production, and sale or use of the products.

Even before passage of this law, many PRC electronics makers were already taking an eco-design approach to comply with the EU laws. Many have eliminated certain toxins from their products and have set up research and development labs to come up with alternative substances. Some have already hired subcontractors for the recycling. Further, the Government plans to establish a special fund to defray some of the manufacturers' costs that arise from compliance and will also encourage manufacturers and other parties to invest in establishing companies that can recycle e-waste.

Sources: Wang, Peter. 2005, May. Precious Waste: China National Resources Wants to Grow the Recycling Business into a Trillion-dollar Industry in the Country. *Asia Inc.* Available: http://www.asia-inc.com/May05/Fea_precious_may.htm
EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1
Global Sources. 2006. WEEE Yields More Lightweight, Modular Devices. 11 July. Available: http://www.electroniccomponents.globalsources.com/gsol/I/PCB/a/9000000076730.htm

phase-out schedule for a particular product or input substance or process. The most common form is a ban on the use of a particularly toxic material or a material whose derivation has severe environmental consequences. These often take the form of restrictions on hazardous substances (RoHS) legislation. More definitive forms are the banning of an entire product whose production, use, or disposal has a strong environmental impact, or the use of an environmentally inefficient or toxic production process. In Europe, a recent RoHS directive banned the use of certain hazardous substances in electrical and electronic products from July 2006.

In addition, in June 2007 a new EU regulation on chemicals and their safe use came into force. It deals with the registration, evaluation, authorization, and restriction of chemical substances (REACH). The REACH regulation gives greater responsibility to industry to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers will be required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency in Helsinki. The REACH regulation also calls for the progressive substitution of the most dangerous chemicals when suitable alternatives have been identified.[117]

Japan's leading role as an electronics manufacturer has put it at the forefront of the DfE movement in Asia and the world. In a short span of time, the Government has developed legislative frameworks and electronics-related industry groups have established voluntary initiatives that are among the most progressive in the world. The Law for Promotion of Effective Utilization of Resources sets targets for computer manufacturers related to the following:

- use of raw materials in PCs (e.g., by adopting small or lightweight parts for cabinets);
- use of reusable parts; and
- promotion of the long-term use of PCs by facilitating repairs and creating parts that allow longer use, as well as making information relating to upgrading and opportunities to repair computers known to consumers.[118]

European and Japanese initiatives, while they are applied only regionally and cover only a fraction of all the hazardous substances used in electronics manufacturing, are having a huge impact throughout Asia. When a region-wide economy such as the EU has introduced environmental policy and regulation targeting the regulation of whole-product life cycle or supply chain, the impact of the policy and regulation tend to be transferred to other regions. This is

117 EUROPA. Available: http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm

118 EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1

Box 4.4: Extended Producer Responsibility in the Republic of Korea

The Republic of Korea has an advanced extended producer responsibility (EPR) structure that includes four types of packages, 10 types of electrical and electronic equipment, and four types of batteries, tires, lubricants, and fluorescent lights. One of the important features of their system is that, instead of relying on producers to take back spent products (as is the case in Japan and other countries), they delegate this responsibility to third parties, to so-called producer responsibility organizations (PROs), which are paid by the producer for spent-product management. The Republic of Korea has 11 such PROs, centered on different recyclables. These includes PROs for cans, expanded polystyrene, glass bottles, lubricants, electrical and electronic equipment, batteries, fluorescent lights, paper packaging, tires, and plastic.

The country has learned a number of important lessons in implementing its system. For instance, while items under EPR are categorized by the product or package names, harmonized system codes mainly cover products, not their packages. Therefore, there are some involuntary free riders importing packaging waste. Also, labeling requirements are not harmonized between countries, making EPR difficult on imported goods. Another lesson is the necessity to standardize packages in the country to allow for more reuse.

One of the more important lessons centers around the PROs. This system has created a monopoly in each of the business areas. Importers do not have enough warehouses and production facilities, making it difficult to meet the EPR regulations. In response, the Government has suggested lowering the entry barrier to PROs.

Source: Notes from Workshop on Extended Producer Responsibility (EPR) and International Material Flow. 2006. 14 February, Asian Development Bank, Manila.

happening through voluntary industrial standards spread by supply chain relationships (Voluntary Initiatives in Chapter 9). It is also happening through introduction of similar legislation in the region (Box 4.3).

Extended Producer Responsibility and Take-Back Provisions

Other product-specific laws promote product stewardship. These laws call on those in the product life cycle—from designers, manufacturers, retailers, and consumers to waste managers and disposers—to share responsibility for reducing the environmental impacts of products. Several related terms (e.g., shared responsibility, extended product responsibility, manufacturer responsibility, and extended producer responsibility) are often used interchangeably, although each term differs slightly in its assigning of roles for responsibility of a product's life cycle among business, government, and civil society. Common products that have been the subject of product stewardship initiatives include batteries, packaging, appliances, hazardous materials, and electronics.

From a business perspective, EPR focuses primarily on manufacturers. EPR is an environmental policy approach that shifts responsibility (physically and/or economically, fully or partially) upstream toward the producer and away from public waste management and recycling authorities. While other policy instruments tend to target a single point in the chain, the EPR approach considers the environmental characteristics of products and production processes throughout the product chain, including the postconsumer stage.

Some EPR programs are voluntary, but many are mandatory, including laws requiring that certain products be the targets of "take-back" programs. The Republic of Korea implements its own unique system (Box 4.4). Take-back provisions require producers of products to make easier steps to take back their products for recycling. This motivates the producer to design the product with recyclability of the materials in mind and especially to reduce the content of toxic materials that may be difficult to dispose.

Where companies are responsible for after-sales impacts of their products, all the way to product take-back at the end of consumer use, EPR provides incentives to businesses to take an LCA-based approach to their products and to incorporate environmental considerations in the design of their products. Ultimately, product stewardship and EPR return to the principles of DfE and require investments in ecodesign, recyclability, ease of dismantling, and logistics of products returning to companies or designated agents.

A key aspect of putting EPR into place involves "reverse logistics." Reverse logistics refers to all of the related activities involved in collecting, disassembling,

Box 4.5: Practical Aspects of Computer Take-Back in Japan

The Japan Electronics and Information Technology Industry Association (JEITA) developed details of the computer take-back scheme in which a label affixed to personal computers (PCs) would indicate that a PC was sold after 1 October 2003 and can be picked up from a drop-off point for free. JEITA also developed a PC pick-up system in cooperation with Japan Post, (the postal service of Japan), that takes advantage of the ordinary parcel delivery system used within Japan. JEITA provides information for recycling charges for each manufacturer on its PC3R web page, under which notebook PCs, liquid crystal display (LCD) monitors, combined LCD monitors and PCs, and the desktop case unit of desktop PCs can be collected for 3,150 yen (¥), and cathode-ray tube (CRT) monitors, combined CRT monitors, and PCs can be collected for ¥4,200.

Participating members in the PC pick-up system send out postage documentation to the PC user, which the user can then attach to a packaged used PC and either take the packaged used PC to one of 20,000 Japanese post offices or schedule to have the packaged used PC picked up from their own home without charge. Japan Post has a network for distributing used PCs to the participating manufacturers, paid for by the participating manufacturers.

Participating members in the scheme include JEITA members and associate members. As of April 2005, there were 39 participants in the scheme, reportedly covering over 90% of the domestic home PC sales market in Japan.

Source: EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1

and processing used products, product parts, and/or materials to ensure environmentally acceptable recovery. Establishing a smooth path for product take-back can turn an onerous responsibility into a strategic advantage if one company or country gets ahead of others in establishing its reverse logistic chains.

Internationally, the EU; Japan; Republic of Korea; Taipei,China; and several US states have introduced legislation making producers responsible for their end-of-life products. Most notable is the European Directive on Waste Electrical and Electronic Equipment (WEEE), which requires producers to take back computers and appliances at their own cost.

The WEEE directive includes a broad scope of product categories. It requires producers to provide free collection for end users, mandates the removal of specified substances and components, requires producers to finance the systems (at least from the collection sites), and provides for financial guarantees. However, while the directive does allow for some flexibility from country to country, it shows how difficult it is to implement similar regulations across different countries. Because national financing and collection schemes are not consistent from country to country, a number of problems have arisen, including

- significant delays in providing collection systems in certain countries,
- inability of countries that export electronic waste to ensure sound management in the importing country, and
- financing questions in cross-border reuse trade about which party should take responsibility for final end-of-life disposal.[119]

Despite these challenges, when a regional economy like the EU has introduced environmental policy and regulation targeting the regulation of whole-product life cycle or supply chain, the impact of the policy and regulation tend to be transferred to other regions. This is true in Asia, which accounts for increasing exports of WEEE products to EU countries. While there is a great deal of speculation and reluctance to act, changes are gradually occurring through voluntary industrial standards spread by supply-chain relationships and also through the introduction of similar legislation in the region.

In the region, Japan has been the most active in keeping up with the trends and emerging requirements for product take-back and recycling. This is apparent in policies and programs being implemented for computers, mobile phones, batteries, and cars.

- Computer manufacturers in Japan have been required to recycle computers from businesses

119 ADB. 2006. Notes from Workshop on Extended Producer Responsibility (EPR) and International Material Flow. Manila: ADB. 14 February.

since 2001 and have been required to take back used PCs since 2003 (Box 4.5). A network of collection centers has been set up using the 20,000 offices of Japan Post.

Source: AFP.

About 500,000 computers (about 9,000 tons) are recovered for recycling each year. A fee to cover the cost of recycling (about $30–40) is now added to the price of the PC at purchase.[120] Once collected, much of this stockpile of computer components is shipped to other Asian countries for actual dismantling, reuse, or recycling, a controversial practice that is discussed in Chapter 10.

- The Law for the Promotion of the Effective Utilization of Resources addresses battery take-back, labeling, and reuse. Based on this legislation, various programs have been developed in Japan. The Battery Association of Japan has developed a voluntary color-coding scheme to facilitate battery sorting and recycling. The color-coding scheme is based on the battery chemistries and includes color-code schemes for nickel-cadmium, lead-acid, lithium-ion, and nickel metal hydride chemistries. The scheme requires that these different battery types be identified using specific colors and that the chasing arrow symbol be applied to batteries and recyclable battery packaging. Additionally, the Japan Battery Recycle Center (JBRC), an organization of battery and appliance makers, facilitates and advises industry and consumers on battery recycling issues.[121] The rest of Asia is progressing at a slower rate. Some movements in recycling spent batteries are starting in the PRC and Taipei,China, but no significant infrastructure exists.[122]
- From the beginning of 2005, Japan has also stepped up its efforts to recycle cars and prevent dumping them illegally by enforcing a new law requiring manufacturers to charge owners for recycling their vehicles. Under the law, automakers and car importers are required to collect and recycle chloroflourocarbons, air bags, and residue from the 4 million shredded vehicles each year. Japan aims to increase its car-recycling rate to 95% by 2015 from a current level of around 80%. The purchase price of a new car will include the recycling cost, while existing car owners will be charged at their next mandatory vehicle inspection. However, the export of secondhand vehicles from Japan is not prohibited.[123] Toyota, Volkswagen, and other major auto manufacturers have joint ventures to create advanced car disassembly and recycling centers.
- A major producer of mobile phones instituted a "take-back" scheme for its products throughout Asia and the Pacific. Customers are encouraged to dispose of their used mobile phones, batteries, and accessories in designated recycling bins at various sites to ensure that these obsolete products are properly recycled and disposed of. Since its introduction in June 2000, the take-back scheme has been implemented across the region. The company partnered with a Singapore-based recycling company certified by the local Ministry of Environment to ensure that used mobile phones, batteries, and accessories are recycled in a safe and environmentally-friendly way. It now has more than 120 recycling points in the Asia region.[124]

Developing countries in the region are also beginning to implement WEEE regulations. In India, a national WEEE task force was formed in July 2004. Headed by the chair of the Central

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120 ADB. 2005. *Asian Environmental Outlook: Making Profits, Protecting Our Planet.* Manila.

121 EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1

122 Buchmann, Isidor. 2001, April. *Recycling Your Battery.* Available: http://www.buchmann.ca/Article16-Page1.asp

123 *Recycling Today.* 2004, 29 Dec. Japan Set to Start Vehicle Recycling Law. Available: http://www.recyclingtoday.com/news/news.asp?ID=6948

124 ADB. 2005. *Asian Environmental Outlook: Making Profits, Protecting Our Planet.* Manila.

Pollution Control Board (CPCB), the task force consists of representatives from relevant government departments, Ministry of Information Technology, regulatory agencies, NGOs, industry associations, experts in the field, and producers, both formal and informal. The mandate of the national WEEE task force is to identify, plan, and implement all issues related to e-waste in India. It has five thrust areas: policy and legislation, baseline study, restructuring and recycling, EPR, and awareness raising.[125]

When introducing EPR schemes, it is important to understand their limitations. In the EU, there is growing concern among policy makers that EPR policy shows some limitations for reduction and reuse of materials due to the cross-border life cycle of products. Without taking into consideration international trade, there may be a risk of a free-riding of one country's recycling mechanism through resource recovery abroad or adverse environmental impacts beyond domestic jurisdiction. These issues are discussed in Chapter 10.

Green Purchasing

Progress has also been made in the region concerning green purchasing—the selection and acquisition of products and services that most effectively minimize negative environmental impacts over their life cycle of manufacturing, transportation, use, and recycling or disposal. Green purchasing complements EPR legislation. New government regulations in Japan and the Republic of Korea require the adoption of green procurement practices, which will serve as models for other countries in Asia and the Pacific.

Since 2001, Japan has implemented the Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities. Each ministry and agency is required to track annual purchases and report them to the Minister of Environment. The law also requires manufacturers or service providers to provide information on the environmental impacts of items they offer for sale. The Basic Policy on Green Purchasing was released in March 2004. About 45 types of eco-friendly goods and services are specified in detail in the Basic Policy, with procurement target-setting guidelines for each (generally a ratio of the specified products to the total number of that product category purchased in the year).[126] In June 2005, the Republic of Korea introduced similar mandatory green procurement for 20,000 public institutions.

Preferential government procurement may offer extra weight in competitive bidding to firms that can demonstrate that they are engaged in a plan for greater resource efficiency, have received a relevant public rating or award, are certified to ISO 14001, or have in some other way demonstrated that they are pursuing resource efficiency. Governments that feel more confident in their position may restrict procurement in certain areas to only those firms that have certain accreditation or meet defined standards. Government represents a major part of some markets, so such measures create a strong influence on firms to change their behavior.

Biomass Policies and Programs

A major share of Asian countries' waste stream is biomass, most of it discarded in landfills. Industries, public operations, and households waste valuable natural resources at a significant cost to the economy. Only a few types of discarded biomass are now recovered, e.g., landscaping discards to compost and some food scraps for animal feed. Most current recovery of biomass discards operates at a relatively low economic value. There are opportunities for capturing much higher benefits.

Composting can significantly reduce the volume of the biomass waste stream, offering economic advantages. The region has a high potential for composting because the waste in many developing countries includes a high percentage of organic material, and many household organic wastes, including wastes from restaurants, are collected for animal feed throughout the region.

Successful composting programs tend to utilize labor-intensive systems to separate materials and have a high degree of community involvement (Chapter 6). To build on successes in the region, policy makers need to evaluate the relative costs and value derived from competing uses for discarded biomass (e.g.,ß composting, animal feed, and generation of bioenergy). What uses are best adapted to which types of biomass? What are the costs of collection, separation, and construction of

125 3R Knowledge Hub Secretariat. 2007. *Gap Analysis in Selected Asian Countries.* Bangkok: AIT.

126 EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1

Box 4.6: Policy Options for Managing Biomass

The following set of goals and policy options is designed to stimulate consideration of possible recommendations for managing the large volume of organic material discards, as well as the issues in the implementation of policy options appropriate to the region.

1. Manage biomass as a resource, not a waste

Goal A: Reduce waste of biomass at the source using goals specific to each major source.

Policy option 1: Set aggressive waste reduction goals for biomass, with indicators and timelines for major industrial and commercial sectors, public utilities (such as sewage plants), and residences. Include mechanisms for monitoring and compliance and appropriate balance between incentives and regulation.

Policy option 2: Provide support and incentives for waste minimization programs for industry sectors and government operations responsible for large waste streams of biomass.

Policy option 3: Provide structures for source separation at household and community levels.

Policy option 4: Encourage niche collection not packer trucks (e.g., paper collection versus mixed collection trucks).

Goal B: Increase the rate of recovery of discarded biomass from landfill to productive use.

Policy option 5: Set biomass recovery goals, indicators, and timelines for all major types.

Goal C: Shift biomass recovery toward producing higher-value benefits.

Policy option 6: Increase research and development funding for "green" chemistry and advanced recycling processes and equipment specific to integrated recycling and reuse of biomass.

2. Develop a viable biomass processing industry

Goal A: Increase the number, size, and variety of companies recovering discarded biomass for fuel, power, and materials at the rate necessary to achieve the goals set above, and invest in their stability, profitability, and financial sustainability.

Policy option 1: Create incentives promoting business development in the biomass processing cluster, including tax holidays, loan guarantees, and public-private investment funds.

Policy option 2: Develop revolving loan funds, venture funds, and other small business finance programs for biomass recovery businesses.

Policy option 3: Invest in materials banks that stockpile recycling commodities and buffer fluctuations in demand for recyclable materials. Government guarantees can create price floors for recovered materials, a concept similar to preferential electricity purchase rates for "green" energy.

Policy option 4: Use the avoided costs of public solid waste management to support financing of resource recovery business development and infrastructure. Factor in public benefits of business and job development.

Policy option 5: Provide financial support for commercialization of biomass technologies, including

a. market instruments, setting specific market share targets for the use of biomass, tax reductions (land, income and value-added taxes), and loan support; and

b. tax reform, with tax credits and economic incentives for reducing production of biowaste and using recovered materials. Expand tax on virgin materials extraction, waste generation, and pollution; provide tax incentives for manufacturing and remanufacturing using recovered materials.

Policy option 6: Phase out subsidies for extraction of virgin materials and traditional waste management. Change tax laws, costs of public services, and balance in research and development spending to make recyclable biocommodities and bioenergy more competitive than those from virgin resources.

Goal B: Support the development of emerging technologies and increase the success rate of new businesses in emerging biomass recovery fields.

Policy option 7: Reserve a portion of funds supporting business development for emerging technologies.

Continued on next page

Box 4.6 continued

Policy option 8: Develop biomass recovery business incubators and training centers.

Policy option 9: Provide incentives for development of biomass processing complexes in resource recovery eco-industrial parks.

Goal C: Plan for utilization of crops for bioenergy and biomaterials in balance with the utilization of residual biomass and with the need for food security.

Policy Option 10: Set quotas and guidelines for utilization of dedicated crops and farm residuals defined by the need to maintain a secure food supply and healthy farms and rural regions.

Policy option 11: Provide incentives for following sustainable farming practices in any biofuel crop cultivation.

Goal D: Establish environmental and social performance goals and indicators for the industry.

Policy option 12: Apply all standard environmental, health, and safety regulations; and support voluntary initiatives toward cleaner production.

Policy option 13: Support entrepreneurial development and workforce development so that communities and local citizens benefit from the biomass industry.

3. Develop an integrated materials management system

Goal A: Build organizational infrastructure for handling complexity.

Policy option 1: Increase research and development funding and partner with trade associations to develop the systems approach required to handle complexity.

Policy option 2: Map major sources, volumes, routes, and users of biomass in geographic information system and update often.

Policy option 3: Develop a market-driven, flow-management system.

Goal B: Collaborate to realize the combined economic development and environmental protection offered by high-level biomass recovery.

Policy option 4: Support development of an industry association.

Policy option 5: Establish a coordinating taskforce, including agriculture, forestry, economic development, civic infrastructure, trade associations, and citizen organizations.

Policy option 6: Develop regional materials-recovery facilities located for easy access by haulers, industry, and citizens.

Source: Lowe, Ernest. 2003. *Report to the Dalian Development Zone on the Eco-Planning Process Phase 1*. RPP International and Dalian University of Technology.

facilities for these options? What is the value of the different outputs? What is the payback period for the investment required?

Management of biomass processing involves a complex system characterized by many sources, types of materials, processing technologies, and products. Dozens of uncoordinated agencies and organizations are responsible for biomass production, use, discard management, and business development. This system needs a mechanism to manage logistics and allocate biomass resources to the different firms producing energy, materials, and products (see page 130 for more detail on biomass business development). Policy makers have a number of policy options to address these challenges (Box 4.6).

Construction and Demolition Debris

Regulations are also requiring construction enterprises to improve management of their construction and demolition debris. Through the Construction Waste Recycling Law of 2000, Japan requires enterprises that undertake new construction to classify and recycle construction wastes generated during the construction. The law targets concrete, asphalt, chipped wood, and mixed construction wastes. Partially as a result of the law, construction waste has steadily decreased during the last decade. During 1995–2002, waste volume decreased by 20%, recycling rate of construction wastes rose from 59% to 92%, and quantity of final disposal decreased by 83%.

Source: AFP.

Other laws and initiatives that seek to improve the recycling and disposal of construction and demolition debris include the following:

- In the Republic of Korea, the Act on the Promotion of Construction Waste Recycling (2003) became effective in 2005. Under the act, any construction work contracted by a public agency must use more than a certain level of recycled aggregate. The Minister of Construction and Transportation is required to set quality standards for recyclable aggregate by type of use and has the authority to certify products.
- In Thailand, the Construction and Demolition Waste Management System, a cooperative project between the German Agency for Technical Cooperation (GTZ) and the Pollution Control Department, aims to develop guidelines and criteria for managing construction and demolition debris. These guidelines will provide stakeholders the methodology for recycling and reuse of debris as well as for preventing illegal dumping and other environmental impacts.
- In Hong Kong, China, the Special Administrative Region Government—through its roles as both construction client and contractor—has required that in its own operations, inert materials must be sorted out from the construction and demolition debris for reusing and recycling, and that recycled building materials be used in construction.

Policies to Promote Energy Efficiency

Energy supply is a critical issue in the future of Asian economies, requiring new technologies and new approaches to the efficient use of energy resources. Countries should be aware that EE can be significantly increased. Across all sectors, gains in EE can reach 35% in some developing countries. The energy conservation potential in India, for example, was estimated to be about 23% of current energy consumption in various sectors in 2002.[127] The PRC could save 300 million tons of coal equivalents if their level of energy conservation could reach that of the most advanced countries.[128]

Increasing EE has many benefits, including easing growth in energy demand and upward pressure on energy prices, improving energy security, and improving air quality. It is also a key strategy to combat potential problems associated with global warming. In July 2005, the Group of Eight (G8) adopted the Gleneagles' Action Plan on Climate Change, Clean Energy and Sustainable Development. This plan called for substantial improvements in EE and aims to shift a growing share of investment toward cleaner and more efficient energy technologies.

EE covers many diverse and distinct market segments, all targeting the creation of a low-carbon, sustainable energy future. Examples include supply-side efficiency in power generation, transmission, and distribution; grid-connected and off-grid renewable energy; industrial EE, including changes in production technology; building end-use efficiency, including commercial, government, and residential sectors; municipal infrastructure, such as street lighting, water, waste and sewage treatment, and pumping; transport efficiency, including urban mass transit; biofuel substitution for fossil fuel; irrigation, such as efficient pumps, foot valves, and pipe sizing; and equipment and appliance standards.

Some of the actions that countries can take to improve EE (Table 4.4) are:

- developing and adopting new decrees, laws, ordinances, and regulations mandating EE and energy conservation technologies and practices;
- removing barriers to new investment or EE retrofit projects by such measures as: improving

127 Lodha, Shri R S. 2002. Welcome Address. International Conference on Strategies For Energy Conservation in The New Millennium, New Delhi, 23–24 August. Available: http://www.ficci.com/media-room/speeches-presentations/2002/aug/aug23-energy-lodha.htm

128 Ying, Wang. 2005, 20 Jan. *China Daily*. Spotlight Shone on Energy Conservation. Available: http://news.xinhuanet.com/english/2005-01/20/content_2484389.htm

Table 4.4: Overview of Building Energy Efficiency Policies in Asia

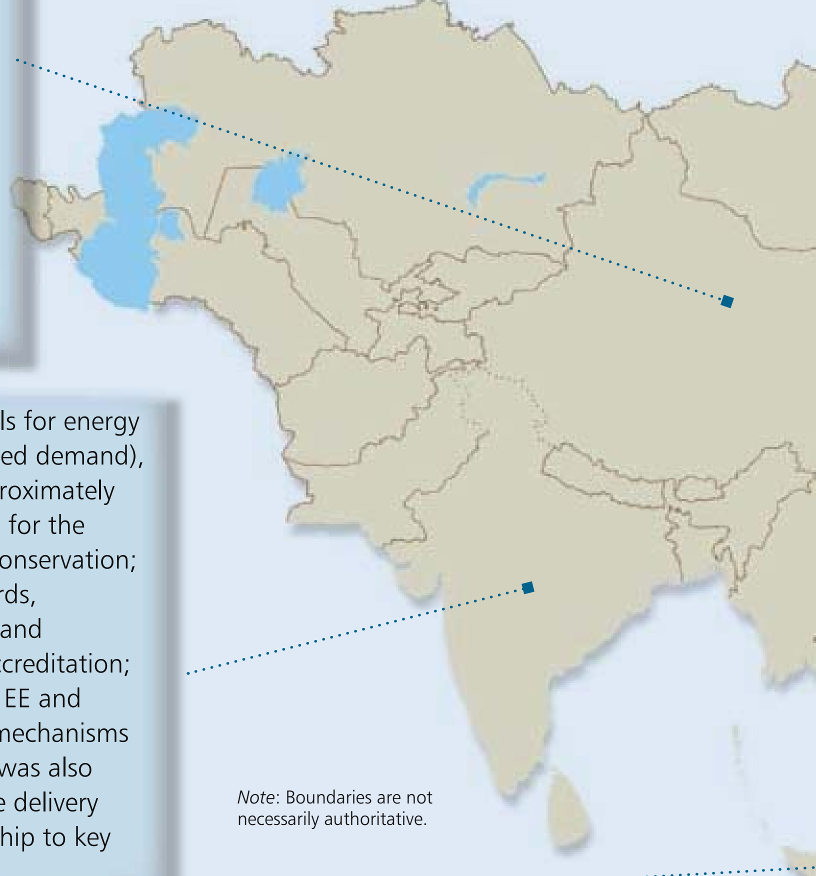
	People's Republic of China	Hong Kong, China	India	Indonesia	Japan	Malaysia	Philippines	Singapore	Republic of Korea	Taipei,China	Thailand
Minimum Energy Performance Standards/Codes											
Appliances/Equipment	●(23)[2]	–	○(3)	●(10)	●(2)& ○(21)	●(5)& ○(1)	●(8)	●(1)	●(16)	●(12)	●(9)
Buildings	●	●	●(P)[3]	○	○[4]	○	●	●	●	●	●
Labeling of Energy Performance											
Appliances/Equipment	●(2)& ○(36)	○(20)	○(9)	○(5)	○(30)	○(7)	●(11)& ○(1)	○(20)	●(15)& ○(17)	○(28)	●(2)& ○(18)
Buildings	○	○	○	–	○	–	?	○	○	○	?
Green Building Rating and Certification	○	○	○	–	○	–	P	○	○	○	–
Financial Incentives											
To Stimulate Performance-plus Supply	P	–	–	?	✓	✓	?	✓	✓	?	✓
To Stimulate Demand	P	✓	–	?	✓	✓	?	–	✓	✓	?
Industry Capacity Building											
Centers of Excellence	✓	✓	✓	?	?	✓	–	✓	✓	?	✓
Energy Performance Benchmarking	–	✓	–	–	?	✓	–	✓	?	✓	?
Skills Enhancement	✓	?	✓	?	✓	✓	✓	✓	?	?	✓
Sponsored Research and Development	?	?	–	?	?	?	?	✓	?	?	?
Building Audit Programs	?	–	✓	–	✓	✓	–	✓	✓	✓	✓
Leading-by-example Programs											
Government Modeling	✓	✓	✓	–	✓	?	✓	✓	✓	✓	?
Demonstration Buildings	✓	✓	✓	?	✓	✓	–	✓	?	✓	✓
Consumer Awareness Raising											
Public Advertising	?	✓	✓	?	✓	?	✓	✓	?	✓	✓
School Education Programs	?	✓	?	?	✓	✓	✓	✓	?	?	?
Policy Implementation											
Enforcement Infrastructure	P	✓	–	–	✓	–	–	✓	✓	✓	–

● = Mandatory, ○ = Voluntary, ✓ = Have Program, P= Planned, ? = Unknown, – = None/Limited

Source: Hong, Wen. 2007. Trends in Asia's Building Energy Efficiency Policies. Presentation at International Conference on Climate Change. Hong Kong, China; 29–31 May. Available: http://www.hkie.org.hk/iccc2007/docs/PPT/5A%20-%20Energy%20Efficiency%20Policies.ppt

Figure 4.4: Regional and National Policies to Enhance Energy Efficiency in Selected Asian Countries

People's Republic of China: In 2007, the country set a new target of reducing energy intensity of the nation by 20% by 2020 in its 5-year economic development plan. The 2005 Energy Conservation Plan calls for the following: retrofits of coal-fired industrial boilers; district cogeneration plants, residual heat and pressure utilization, petroleum savings and substitutions, improvements in motor systems, optimization of energy in key industries, building energy efficiency (EE) and green lighting projects, and energy conservation in government agencies. The Energy Conservation Association (EMCA) will play a role in raising awareness and capacity building among energy service companies and customers, highlighting the need for collaboration and stakeholders' involvement.



Note: Boundaries are not necessarily authoritative.

India: The Energy Conservation Act of 2001 calls for energy savings of 95,000 gigawatts (or 13% of estimated demand), as well as voluntary energy saving target of approximately $90 million per year by industry. It also provides for the following: Indian industry program for energy conservation; demand-side management in transport, standards, and labeling; energy efficiency (EE) in buildings and establishments; professional certification and accreditation; manual and codes; EE policy research program; EE and conservation in school education; and delivery mechanisms for EE services. The Bureau of Energy Efficiency was also established to institutionalize EE services, enable delivery mechanisms in the country, and provide leadership to key players in the energy conservation movement.

Regional: On 23 August 2007, the first East Asian Summit Energy Ministers' Meeting was held in Singapore. In recognition that improving EE and conservation is one of the most cost-effective ways of enhancing energy security and addressing climate change, the ministers agreed to formulate, on a voluntary basis, individual, quantitative, and where possible, sector-specific EE goals and action plans, with the view to presenting the first goals and action plans in 2009. The ministers also agreed to monitor each country's progress toward its EE goals.

Malaysia: The Pusat Tenaga Malaysia (PTM), or "Malaysia Energy Centre," was established in 1998 as a focal point for various energy-related government and private sector activities, specifically including energy planning and research; EE; and technological research, development, and demonstration. Although PTM is registered as a nonprofit company, it receives administrative support from the Ministry of Energy, Communications and Multimedia.

Japan: The country's Energy Conservation Law of 1979 was amended in 2005 to include the 13,000 factories across Japan that are large- or medium-sized energy consumers, as well as the product manufacturers, transportation businesses, and buildings consuming a lot of energy. A set of guidelines for achieving energy efficiency was also added to the law.

Thailand: The Energy Conservation Center of Thailand (ECCT) was set up by the Government in 1987 with support from the Federation of Thai Industries. A World Bank loan was used to stimulate energy management in industry by providing training and services to customers on both a paid basis and through government-sponsored programs. The country is using a number economic instruments to promote energy efficiency, including favorable loans allocated by the Energy Conservation and Promotion Fund and various Thai banks.

Singapore: In the transportation sector, the city-state employs a vehicle quota system, which employs an open bidding process for certificates of entitlement to own a vehicle. This is combined with a high initial registration cost (about 150% of the vehicle's market value); an annual road tax that increases with engine capacity, along with a surcharge for older vehicles; and electronic road pricing based on a spatial and temporal pay-as-you use principle.

Indonesia: The Energy Plan for 2003–2020 stipulates the following: increased business sector participation in setting market incentives; increased investments in capital-intensive power plants and transmission and distribution grids; infrastructure development to give the public access to energy and exploit energy for export; and strategic partnerships between domestic and international energy industries in discovering domestic and foreign sources of energy.

Source: ADB.

access to sustainable energy or carbon reduction financing; developing public-private partnership investment revolving loan funds; providing tax breaks that offset EE investments; providing technology due diligence and investment planning services; and establishing legal frameworks for energy service companies;
- developing and adopting frameworks for DSM, including residential DSM programs and initiatives to accelerate utilization of EE lighting and appliances in households;
- developing and promoting high-performance energy-efficient building design standards and/or codes;
- developing renewable energy policies and strategies;
- promoting rail-based intermodal transportation planning;
- developing and promoting cleaner vehicle technologies and alternative fuels; and
- designing and managing all public assets and operations for high-energy performance, in recognition that government is a major user of energy.

Japan was the first nation in the region to pass a law on energy conservation. The country's Energy Conservation Law of 1979 was amended in 2005 to include the 13,000 factories across Japan that are large or medium size energy consumers, as well as the product manufacturers, transportation businesses and buildings consuming a lot of energy. A set of guidelines for achieving EE was also added to the law. In addition, the Energy Conservation Center of Japan (ECCJ) was established with Japanese government and corporate support to assist with research on and implementation of energy conservation programs, accreditation of energy managers under the Law Concerning the Rational Use of Energy, and dissemination of information on energy conservation. ECCJ is also responsible for administering the International Energy Star program in Japan. Largely as a result of these measures, carbon dioxide emissions from industries have been reduced from 482.2 million tons (Mt) in 1990 to 455.6 Mt in 2005, and energy consumption in the same time period has decreased, despite the fact that Japan's industry has continued to grow.

Following Japan's lead, some countries in the region have passed new legislation that provides targets, policies, regulations, and support frameworks for EE actions (Figure 4.4). However, despite a widespread shift in national environmental legislation from limiting pollution levels to using energy more efficiently, many countries in the region still lack effective means to promote EE. Often, governments allocate insufficient funds for policy implementation and enforcement, and local authorities are often hesitant to fine companies for fear that they will move. Moreover, energy prices in many countries are still subsidized at below-market levels, which discourages investment in efficient energy use and increases waste.

Developing countries will continue to improve their policy frameworks to promote EE across all sectors, including residential and industrial energy use. Much of the focus will continue to be on mandatory components, such as mandatory energy audits or the appointment of energy managers in every industrial facility, but financial schemes, such as revolving funds, are becoming increasingly common. In addition, policies and programs will likely become more linked than at present to national programs for reducing GHG emissions or promoting renewable energy. Some of the more common measures are discussed below.

Energy Audits

One of the most common EE policy measures supports voluntary or mandatory energy audits, which are detailed surveys of energy use in an industrial firm, transport company, or building. Audits are conducted by an energy expert and provide technical and financial information to consumers about actions they can take to reduce their energy bills. The auditor prioritizes potential conservation practices, change of fuels, equipment retrofits, and possible investments in new equipment. The report usually includes a summary of energy savings, a budget for these options, and often a financing strategy.

Typically, energy audits are mandatory in countries where energy conservation laws exist. As part of India's comprehensive EE policy, an audit program was required to expand EE in energy-intensive industries, government buildings, and facilities as well as utility DSM programs. Audit programs are usually funded, at least in part, by public agencies or utilities.[129] In the Philippines, the Department of Energy plays an important role in providing financial support to many private energy audit companies.

Some audit programs target specific sectors. For example, in Hong Kong, China, the Government has been implementing energy audit programs in its buildings since 1993. As of January 2005, energy audits and re-audits had been performed in 224 major government energy-consuming buildings. Pilot tests on energy management opportunities using innovative energy-efficient equipment related to lighting, air conditioning, and vertical movement have also been carried out to achieve energy savings in government buildings since 1999. The tests were successful and substantial energy savings were achieved.[130]

In Malaysia, the Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) targeted over 700 industrial sites in eight industrial sectors including cement, ceramics, food, glass, iron and steel, paper, rubber, and wood. The program had a wide range of activities, including benchmarking, energy auditing, energy rating, supporting energy service companies (ESCOs), establishing an association of energy professionals, technology demonstration, and an EE financing program.[131] According to the MIEEIP team, the energy audits conducted in 43 of the 48 most energy-intensive factories show that electricity usage will be reduced by 5.6% and fuel demand by 26.7% annually if all measures recommended are implemented by each factory. This would result in total energy savings of 22.3% per annum across the 43 factories.[132]

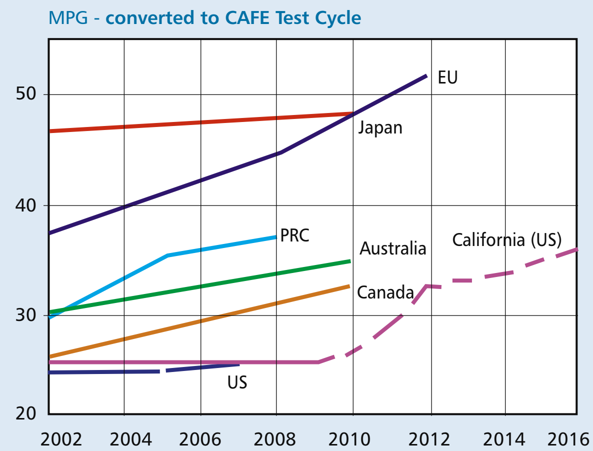
Energy Efficiency and Emissions Standards

Given the rapid increase in ownership levels of domestic appliances, the growth in domestic electricity consumption is expected to be high in the region. Despite recent efforts in many countries, there are still significant EE differences between appliances sold in developing countries and in industrialized countries, which suggests a substantial potential for energy savings.[133]

In some countries, efficiency standards and labels for household electric appliances have also been introduced to reduce energy consumption and to make energy performance "visible" to consumers. Both standards and labels stimulate technological change. With standards, manufacturers are obliged to increase products' efficiency to conform to legislation to remove the least efficient products from the market. This usually entails imposing minimum energy performance standards for appliances, such as refrigerators, freezers, and electric storage water heaters, or for industrial equipment.

From 1981 to 2003, the average EE of refrigerators was improved in Japan by a factor of five due in large part to "best available targets" set by the Government. A June 2003 study by experts in the PRC estimates that improved EE standards for common domestic appliances and major energy-using industrial equipment in the PRC could save almost 60 GW of power by 2020, which would eliminate the

Figure 4.5: Comparison of Fuel Economy and GHG Emission Standards Normalized by CAFE-converted MPG



CAFE = corporate average fuel economy, EU = European Union, MPG = miles per gallon, PRC = People's Republic of China, US = United States.

Source: Feng, A., and A. Sauer. 2004. Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards Around the World. Pew Center on Global Climate Change.

129 ADB. 2006. *Report of the Energy Efficiency Initiative*. Manila. Available: http://www.adb.org/Documents/Reports/Energy-Efficiency-Initiative/execsum.pdf

130 Asia-Pacific Economic Cooperation (APEC). 2005, December. *APEC Energy Overview*. Tokyo: Asia Pacific Energy Research Centre/Institute of Energy Economics.

131 *Malaysia Energy Centre*. Malaysian Industrial Energy Efficiency Improvement Project. Available: http://www.ptm.org.my/mieeip/about.html

132 Ibid.

133 Footnote 129.

need to build and fuel two hundred 300-MW power plants.[134]

In the transportation sector, there are numerous measures that policy makers can take to increase the distance traveled per unit of fuel. Emissions standards can force manufacturers to adopt new technologies and improve design of engines, creating a double benefit of improved EE and reduced pollution. However, several countries in emerging Asia have no formal fuel quality or vehicle emissions road maps in place, such as Bhutan, Cambodia, and Pakistan. Others, like Indonesia, Philippines, and Viet Nam have developed plans for EURO II standards but have not yet finalized the way forward to EURO IV.[135]

In turn, the combination of improved engine and vehicle technology allows countries to enact fuel economy and GHG emission standards. The EU and Japan have the most effective light vehicle fuel economy standards. The PRC is the only country in emerging Asia that has implemented fuel economy standards (Figure 4.5).[136] The PRC began considering the adoption of vehicle fuel efficiency standards and other policies to regulate vehicle fuel economy in 2000 to deal with the rising energy pressures. Maximum fuel consumption limits for passenger vehicles were published on 20 September 2004, with an implementation date of 1 July 2006. These are maximum values that vary by the weight of the vehicle (not average fleet economy figures). A second phase with more stringent fuel economy standards will be enforced from January 2009.[137]

Energy Efficiency Labels

Perhaps the most common (and successful) application of ecolabeling (page 150) is in the EE sector. EE is an increasingly important consideration for consumers buying a new appliance, and there is evidence to suggest that many customers use EE as a tool to differentiate between models.[138] Because energy operating costs over an appliance's life are typically greater than the appliance purchase cost, the operating cost is also known as the "second price tag."

Source: AFP.

Energy labeling schemes, which often complement EE standards, impose a minimal cost on manufacturers and importers, but they can lead to a strong market pull for energy efficient products. Labeling programs are designed to modify the selection criteria of consumers by drawing their attention to the energy consumption of household appliances.

Energy labels for such household appliances as refrigerators, washing machines, and air conditioners are mandatory in some countries, including the PRC, Philippines, and Thailand. The PRC is developing new EE standards and EE label specifications. The label will include the name of the producer, the product brand, the degree of EE, and the energy consumption volume. It will also reference the PRC's EE standards to help consumers determine the product's degree of efficiency.[139]

Energy performance labeling for buildings is also an emerging trend. Internationally, voluntary building rating systems have been instrumental in raising awareness of and popularizing "green" building design. The most well known is the US Green Building Council's Leadership in Energy and Environmental Design (LEED) program. LEED certification is based on a holistic set of design standards for energy, materials, water use, landscaping, and impact on neighborhoods (Box 4.7).

134 Hu, Zhaoguang, David Moskovitz, and Jianping Zhao. 2005, December. *Demand-Side Management in China's Restructured Power Industry: How Regulation and Policy Can Deliver Demand-Side Management Benefits to a Growing Economy and a Changing Power System.* Washington, DC: World Bank.

135 ADB and Department for International Development (UK), in collaboration with the Clean Air Initiative for Asian Cities. 2006. *Energy Efficiency and Climate Change Considerations for On-road Transport in Asia. Manila.*

136 Ibid.

137 Ibid.

138 Gupta, K.P. 2006. *Energy Conservation by Demand-Side Management by Standardization and Energy Labelling. Gujarat Electricity Regulatory Commission.* India Electricity. Pragati Maidan New Delhi. 11–13 May.

139 EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1

Box. 4.7: The Leadership in Energy and Environment Design (LEED) Program

The LEED Green Building Rating System developed by the United States Green Building Council (USGBC) is the nationally accepted benchmark for the design, construction, and operation of high-performance green buildings in the United States. LEED promoted a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

The LEED rating system provides the building industry with consistent, credible standards for what constitutes a green building. To earn LEED project certification, a building project must meet certain prerequisites and performance benchmarks ("credits") within each category. Projects are awarded certified, silver, gold, or platinum certification depending on the number of credits they achieve.

To respond to the escalating demand for LEED certification (the number of organizations seeking certification is growing by double-digit percentages annually), USGBC is now in the process of streamlining application submission and processing.

Source: US Green Building Council. Website on Leadership in Energy and Environmental Design. Available: http://www.usgbc.org/DisplayPage.aspx?CategoryID=19

The program has recently been expanding its reach to countries outside the US.

After the success of building rating systems like LEED in the developed world, the number of green building councils or organizations with similar goals in Asia has increased. Many of these organizations have devised rating systems tailored to suit the building industry of the country where they were developed.

In India, for instance, The Energy and Resources Institute (TERI) is seeking to popularize green buildings using a tool for measuring and rating a building's environmental performance in the context of India's varied climate and building practices. This tool has a number of qualitative and quantitative assessment criteria to rate a building on the degree of its "greenness." The rating applies to new and existing buildings, including commercial, institutional, and residential.[140]

However, while industry-driven initiatives are largely taking the lead in driving the market transformation in developed countries, governments are taking the lead role in most Asian countries. There have been several substantial government initiatives in promoting energy-efficient buildings in the region, particularly since 2000. Recent green building programs have been initiated by governments of the PRC; Hong Kong, China; Japan; Republic of Korea; Singapore; and Taipei,China.[141] In the PRC, for instance, some developers are applying LEED high-performance building concepts, with support from the China Housing Industry Association and private consultants.[142]

In the future, rating systems may be applied to whole cities. The International Business District of New Songdo City in the Republic of Korea has been accepted as a pilot project for LEED's Neighborhood Development program, the first rating system for neighborhood design.

Energy Pricing and Taxation

The use of energy (and its waste) is largely driven by price. Thus, national governments should consider how energy pricing can serve as a tool for effective demand management and can encourage the view of both pricing and management as economic goods. For instance, the generation of electricity, clean coal, wind, solar, and nuclear power all cost more than building coal-fired power plants with no or minimal pollution controls. Power-generating companies cannot afford to build cleaner electrical generation unless governments and the public who need the electricity agree to higher prices as part of a social

140 The Energy and Resources Institute (TERI). *What is TeriGriha?* Available: http://www.teri.res.in/core/griha.htm

141 Hong, Wen. 2007. Trends in Asia's Building Energy Efficiency Policies. Presentation at International Conference on Climate Change. Hong Kong, China. 29–31 May. Available: http://www.hkie.org.hk/iccc2007/docs/PPT/5A%20-%20Energy%20Efficiency%20Policies.ppt

142 Lowe, E. 2003. Interview with Nia Mei Sheng, President of China Housing Industry Association, Beijing. April.

bargain to reduce environmental pollution from the electricity-generating sector. The recent innovation in Europe and North America of encouraging consumers to pay a small premium for energy generated from renewable sources is a good example.

A few countries are implementing taxes on energy use, both to create an incentive for producers or users to become more efficient and also to create revenue to support EE programs. For instance, to support Malaysia's Electricity Supply Industry Trust Fund, established in 1997, electricity generators voluntarily contribute to the trust fund 1% of their electricity sold to the peninsular grid or the transmission network. Proceeds from the trust fund are then used to support, among other things, certain EE projects. The trust fund is managed by a committee of representatives of Malaysian government institutions and independent power producers.[143]

However, in the context of high and rising fuel prices, subsidies and controlled prices for energy prevail in many countries. Direct subsidies to lower retail prices for the whole population were used by 19% of the economies for gasoline and 25% for diesel. Direct subsidies or tax breaks for targeted industries, such as farming, fishing, and transportation, and for selected uses, such as cooking and electricity, were used by 53% of the economies. Indirect methods of lowering fuel prices for the whole population, such as regulated pricing, compensatory tax changes, and use of state-owned petroleum companies to absorb losses, were used by 31% of the economies.[144]

Policy instruments intended to improve EE will not work fully until subsidies for energy are significantly reduced or even removed. Subsidized energy prices discourage the implementation of EE projects by artificially reducing the cost of energy and thereby artificially reducing the energy savings associated with greater efficiency.

Favorable Subsidies—Tax Credits and Favorable Loans

In some cases, subsidies can serve to promote EE by targeting specific industries to stimulate technological development. These can come in the form of low-interest loans, direct grants, or preferential tax treatment. In Japan, for instance, the Government offers financial incentives in the form of low-interest financing, industrial improvement bonds, and tax exemptions to support approved voluntary efforts by business operators and building owners for energy conservation.[145] Governments can also use these instruments to promote research and development of resource-efficient technologies, such as through grants to nonprofit institutions and tax credits or similar incentives to firms for research and development expenditures.

It is important to note that such financial measures are not appropriate in all instances and need to be supported by appropriate procedures to avoid undue "regulatory capture" by industry. Such grants and subsidies should be limited to early users and should be phased out when other means are available (e.g., readily available demonstration examples) in order not to distort the economics of the industry.

Favorable loans. Favorable loans for improved resource efficiency, such as soft loans or revolving loans, will encourage producers, particularly SMEs, to undertake changes in process or operation that can contribute to greater efficiency. SMEs are often family enterprises and for various defensive reasons do not carry substantial assets in the name of the company. Therefore, they have difficulty accessing conventional loans requiring collateral. Special loans that recognize the needs of SMEs and that recognize the competitive advantage of such investments (that may not show a corresponding increase in net assets) may promote investment for change.

Loans for preparing bankable projects are also needed to help SMEs to assess their needs and to develop a business plan acceptable to a financial institution. The lack of financial skills and available surplus capital prevents many interested SMEs from developing a business proposal that could access a loan. A loan fund for project proposal preparation should be a revolving fund, with loans for failed proposals written off and for those successful repaid to the fund from the resulting loan proceeds.

Thailand has been active in providing loans to promote EE. One example is favorable loans—

143 EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1

144 ADB. 2007. *Asian Development Outlook 2007 Update*. Manila.

145 Footnote 143.

Box 4.8: Tax Incentives Options to Promote Energy Efficiency

Tax deductions. Under this type of incentive, businesses are allowed to deduct some or all of the cost of investment in energy efficiency (EE) technologies from their annual profits. The savings accrued to the business are equivalent to the amount of tax the company would have otherwise paid.

Tax credits. Tax credit systems allow a business to reduce its total tax liability by some or all of the cost of an investment in EE. Tax credits typically generate more savings to business than tax deductions or accelerated depreciation, because they represent an absolute reduction in the amount of taxes paid, while tax deductions and accelerated depreciation only reduce the amount of taxable profit and therefore reduce taxes only by a percentage of the cost of the investment. In addition, the savings associated with a tax credit are more directly tied to the EE investment.

Tax reductions. Under a tax reduction incentive, taxes on paid on the purchase of equipment, such as value-added tax or import duties, are reduced. In developing countries, reduction of import duties can be significant, as domestic sources of EE technology may be limited, and standard duties on imported equipment may be a substantial barrier to their use.

Accelerated depreciation. These types of incentives allow businesses to depreciate more rapidly the costs of their investments in resource-efficient technologies. The effect of more rapid depreciation is to reduce a business's taxable income compared with use of normal depreciation during the depreciable life of the equipment purchased. Since turning over the capital stock is more difficult in cases where the new cleaner technology is more expensive than conventional technologies, accelerated depreciation of new clean technology is a powerful tax incentive to encourage investment in clean technology, as well as to encourage companies to close out-of-date facilities on a timely basis. Society and the environment are clear beneficiaries, especially when older and more resource-intensive and polluting factories are closed in the process.

Source: United Nations Environment Programme (UNEP). 2006, June. *Improving Energy Efficiency in Asia: A Review of Financial Mechanisms.* Available: http://www.energyefficiencyasia.org/docs/Review%20of%20Financial%20Mechanisms%20for%20EE.pdf

which have a fixed interest rate of less than 4% and repayment in a defined time frame of 7 years—allocated by the Energy Conservation and Promotion Fund (ECPF) and various Thai Banks. Currently, 82 project loans have been approved or are under construction with leverages of $80 million in energy conservation investment. The average investment for each project is $1 million and the average payback period is 2.3 years. The estimated annual energy savings are more than 250 GW and 91 million liters of fuel oil.[146] The program is funded through a 0.07 baht (B) (about $0.002) per liter tax on gasoline.

Another example from Thailand is the Energy Efficiency Revolving Fund, which commenced operation in 2003. Managed by the Department of Alternative Energy Development and Efficiency, the fund was established to stimulate financial sector involvement in EE projects and to simplify project evaluation and financing procedures. The fund provides capital at no cost to Thai banks to fund EE projects, and the banks provide low-cost loans to project proponents. Government intervention in the financing process is minimal.[147]

Tax Incentives. Tax incentives use reduced taxes to encourage desired behavior. Tax incentives tied to EE investments essentially reduce the cost of EE improvement, which serve to encourage more businesses to make that investment and increase demand for EE projects. Tax incentives for resource-efficient investments are typically tied to purchases of specific equipment, such as in a list of equipment identified in advance by the government. There are various ways in which tax incentives can promote investment in EE, including tax deductions, tax credits, tax reductions, and accelerated depreciation (Box 4.8).

The Government of India has offered significant fiscal incentives to promote energy conservation. For example, energy-conservation and energy-efficient equipment is eligible for 100% depreciation, which offers significant tax benefits for customers.[148]

146 Sinsukprasert, Prasert. Department of Alternative Energy Development and Efficiency. 2006. *Government Roles: Regulation and Incentives for EE promotion in Thailand*. UNIDO's Bangkok Industrial Development Club Discussion, Electrical and Electronic Institute, 16 March.

147 APEC. 2005. *APEC Energy Overview*. Tokyo: Asia Pacific Energy Research Centre/Institute of Energy Economics.

148 Prayas Energy Group. 2005. *Demand-Side Management (DSM) in the Electricity Sector: Urgent Need for Regulatory*

Table 4.5: Financial Mechanisms to Promote Energy Efficiency in Selected Asian Countries

Country	Tax Incentives	Subsidies	Lending Programs			Energy Service Companies
			Loan Funds	Guarantee Funds	Bank Windows	
Bangladesh						
People's Republic of China			O	O		O
India	O		O		O	O
Indonesia						
Mongolia				O		O
Philippines	O		O			O
Sri Lanka		O	O	O		O
Thailand	O		O			O
Viet Nam		O				O

Source: UNEP. 2006, June. *Improving Energy Efficiency in Asia: A Review of Financial Mechanisms.* Bangkok.

Financing through Energy Service Companies

A commonly implemented energy sector mechanism in Asia is the development of ESCOs, as shown by Table 4.5. These may finance or assist in arranging financing for the improved operation of a client's energy system by providing a savings guarantee. An ESCO is normally a private company that assesses the potential for energy savings in a public or private client's facilities and subsequently designs and implements energy-saving measures. An ESCO guarantees energy savings and its remuneration is directly tied to the energy savings achieved. ESCOs operate under an energy performance contracting arrangement, whereby the ESCO typically implements a project to deliver EE and uses the stream of income from the cost savings (or the renewable energy produced) to repay the costs of the project.

However, in practice, the use of these contracts is not common unless subsidized by donors. For instance, in the PRC, three pilot ESCOs received support and access to loans and grants from the World Bank and the Global Environment Facility (GEF) in 1998. Their success inspired many more companies to copy the business model. There are now 52 of them and an ESCO association in the PRC. In 2005 alone, the PRC's new ESCO industry put into place over 300 EE projects representing an investment of more than $200 million, saving the energy equivalent of 2.46 Mt of standard coal and an annual decrease in carbon dioxide emissions of nearly 7 Mt. The World Bank and GEF also set up a bank loan guarantee mechanism to help ESCOs finance EE projects.[149]

ESCOs in many countries still face difficult hurdles in obtaining bank financing and equity investment.[150] The problem is generally not caused by a lack of available funding capacity within the local financial markets, but rather an inability of EE projects to access such capacity due to a "disconnect" between traditional asset-based lending and the cash flow-based project financing needed for projects.[151] Thus, there is a need to develop special local bank lending arrangements to provide energy conservation financing. To this end the International Energy Efficiency Financing Protocol (IEEFP) was recently created to accelerate financing of energy savings projects by local financial institutions (Box 4.9).

Demand-Side Management

DSM is an advanced method of improving EE that involves planning, implementing, and evaluating utility-sponsored programs to influence the amount

Action and Utility-Driven Programs. India: Climate Change & Energy Programme. World Wide Fund for Nature.

149 UNEP. 2006, May. *Fighting Climate Change through Energy Efficiency: Local Financing to Slash Energy Waste in China, India, Brazil Said Crucial to Forestalling Global Climate Change.* Available: http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=477&ArticleID=5276&l=en

150 UNEP. 2006. *Improving Energy Efficiency in Asia: A Review of Financial Mechanisms.* Available: http://www.energyefficiencyasia.org/docs/Review%20of%20Financial%20Mechanisms%20for%20EE.pdf

151 Dreessen, Thomas K. 2003. Role of Financing in Building an ESCO/EMC Industry. International Workshop on Energy Efficiency Services Industries. Shanghai. 9 September.

Box 4.9: International Energy Efficiency Financing Protocol (IEEFP)

Developed under the aegis of the Efficiency Evaluations Organization and with support by the Energy Futures Coalition, the IEEFP intends to create a better understanding within local financing institutions of how energy efficiency (EE) projects generate savings from existing operating expenses of energy consumers that equate to new cash flow and increased credit capacity for repaying EE project loans. At the core of the IEEFP is the need to measure and verify the energy savings to ensure the sustainability of the reduced energy costs and the resulting available cash flow to repay the lending institutions. The protocol organization is seeking promotion by multilateral development banks to encourage local banks to invest in implementing widespread energy efficiency. Asia-Pacific Economic Cooperation (APEC) is supporting the initial development of the IEEFP in Thailand. Thus far, the work undertaken by the Thai team has covered some 17 commercial banks. The existence of an EE revolving fund has been effective in encouraging the participation of private banks by providing capital at low interest rates. Although the focus of the IEEFP is on attracting private capital into the energy efficiency market, there are still important roles the public sector must fill to ensure the rapid maturing of the energy efficiency markets.

Sources: Efficiency Evaluation Organization. 2005. Practical Experiences in Applying Savings M&V. Paper prepared for the 1st Asian ESCO Conference. Bangkok. 20–21 October. Available: http://www.asiaescoconference.org/index.php?pageId=1016
Renewable Energy & Energy Efficiency Partnership (REEEP). Status of renewable energy and energy efficiency in South Asia. Available: http://www.reeep.org/media/downloadable_documents/South%20Asia%20background%20paper1.pdf

and timing of customers' energy use in order to use electricity most efficiently. DSM encourages industrial, commercial, and residential consumers to reduce their usage and adjust the timing to reduce the peak load on the energy system.

DSM complements supply-side strategies to help meet a country's growing electric service demands. Measures to encourage consumers to modify their consumption include tariffs designed to stimulate a shift in consumption to off-peak periods and subsidies for consumer purchases of efficient appliances, lighting, motors, etc. End-use EE can reduce both energy and peak power demand, while direct load control can limit peak power demand. The key to the success of these measures is that utilities can implement them for much less than the cost of adding the additional generation capacity that would otherwise be required.[152]

Most developing countries have not yet initiated DSM programs, largely because developing and implementing such programs is complex and most countries do not have the necessary incentives in place. Among the many barriers, there are strong disincentives for utilities to invest in DSM under the existing tariff-setting method in most countries. The electric company's revenues are determined by power sales, so any reduction in the growth of energy demand that would result from EE measures would reduce utility profits. The lack of utility incentives to invest in EE has caused growth in electricity demand to be much greater than necessary.[153]

To work effectively, DSM programs must include financial incentives for utilities to introduce DSM programs that aim to reduce sales. In the process, utility incentives must encourage utilities to transform from commodity producers into service providers. DSM programs must also craft a package of incentives that motivates consumers and trade allies as well. Getting all three groups on board requires integrated resource planning, a technique that generates the least-cost utility plan by considering both supply- and demand-side resources.[154]

Major international donor agencies like the World Bank, United Nations Development Programme (UNDP), and United States Agency for International Development have recently funded national DSM programs in Asian countries, including Indonesia,

[152] United States Agency for International Development (USAID). *Indonesia Demand-Side Management Action Plan.* Prepared by Hagler Bailly Consulting, Inc. under the: Energy Conservation Services Program (ECSP), Energy Policy Development and Conservation Project. Available: http://www.weea.org/USAID%20Reports/Documents/Indonesia%20Demand-Action%20Plan.pdf

[153] Hu, Zhaoguang, David Moskovitz, and Jianping Zhao. 2005. *Demand-Side Management in China's Restructured Power Industry: How Regulation and Policy Can Deliver Demand-Side Management Benefits to a Growing Economy and a Changing Power System*. Washington, DC: World Bank.

[154] USAID. *Indonesia Demand-Side Management Action Plan*. Prepared by Hagler Bailly Consulting, Inc. under the: Energy Conservation Services Program (ECSP), Energy Policy Development and Conservation Project. Available. http://www.weea.org/USAID%20Reports/Documents/Indonesia%20Demand-Action%20Plan.pdf

Malaysia, Pacific Islands, Philippines, Sri Lanka, Thailand, and Viet Nam. Most programs are in the pilot program phase and DSM activity is expected to increase significantly in the medium term.[155]

Carbon (GHG Reduction) Projects

A carbon project refers to a business initiative that receives funding because of the cut in emission of GHGs that will result. They have become increasingly important since the advent of the clean development mechanism (CDM) under Phase I of the Kyoto Protocol—the international protocol of the Framework Convention on Climate Change toward reducing GHG. As one of the three flexible mechanisms under the Kyoto Protocol, the CDM can promote technological improvement by encouraging energy conservation, adoption of renewable energy, and recovery and utilization of methane, thus contributing to sustainable development in developing countries. It can also help improve the energy supply mix, secure energy supply, reduce local pollution, and help reduce GHG emissions.

Despite the high demand to utilize the CDM and continuing improvement in CDM rules, many investors and developers still find it difficult to implement projects. There are many impediments, including the unpreparedness of developing countries to host projects.[156] In addition, most of the existing carbon procurement funds provide payment only on project completion and when the carbon credits are delivered. As a result, many clean energy projects face a critical upfront financing gap that prevents them from being undertaken in the first place.

Despite these hurdles, there has been a steep increase in the number of projects submitted under the CDM for validation and registration, since the protocol came into force in February 2005, and this upward trend is expected to continue in the next few years. Many donor groups like ADB are addressing financing gaps through a number of initiatives. ADB is addressing these through a dedicated Carbon Market Initiative, consisting of a project cofinancing facility (the Asia-Pacific Carbon Fund), a carbon credit marketing facility, and a technical support facility (Box 4.10).

Source: ADB.

A carbon project is appropriate for renewable energy projects, such as wind, solar, low impact-small hydro, biomass, and biogas. Projects have also been developed for a wide variety of other emissions reductions, such as reforestation, fuel switching, carbon capture and storage, and EE. Proposed CDM project activities must demonstrate their contributions to environmental integrity and the host country's sustainable development goals. The resulting emissions reductions may become certified emissions reductions (CERs) when a designated operation entity has produced a verification report submitted to the CDM executive board.[157]

One special feature applicable only to small-scale CDM project activities is bundling. Bundling means clustering projects that are too small to be attractive for investment, even with the additional CER revenues. By using the bundling scheme, small projects can become cost effective and sufficiently attractive with CER revenues. Many community-based projects (e.g., small hydropower), as well as projects for SMEs, can use the bundling scheme to improve their overall financial viability.

It is estimated that the PRC represents at least 50% of the world's CDM market. The PRC's National Development and Reform Commission has established three priority areas for implementing CDM projects: EE, renewable energy, and methane recovery and utilization. The PRC also encourages CDM projects in other areas, such as fuel switching, reforestation, and afforestation. The total GHG reduction potential in the PRC is estimated to be about 777 Mt of carbon equivalent, which includes 545 Mt from EE, 138 Mt from renewable energy

155 International Institute for Energy Conservation. Available: http://www.iiec.org/index.php?option=com_content&task=view&id=126&Itemid=69

156 IGES, Ministry of the Environment, Japan, and Chinese Renewable Energy Industries Association. 2005. *CDM Country Guide for China.* Available: http://www.iges.or.jp/en/cdm/pdf/countryguide/china.pdf

157 IGES and Ministry of the Environment, Japan. 2007, August. *CDM in Charts.*

Box 4.10: ADB's Carbon Market Initiative

Adequate finance and capacity are fundamental obstacles for developing countries trying to adopt cleaner energy technologies. The carbon market initiative (CMI) supports the development of energy efficiency, renewable energy, and other GHG mitigation projects by providing upfront cofinancing for project preparation and implementation. The CMI's Asia Pacific Carbon Fund is now fully operational with over $150 million to cofinance clean energy projects. The CMI also provides experts for technical advice on project development and implementation, documentation, and capacity building.

In addition, it offers its development member countries marketing support for their carbon credits to be sold in the global carbon market, creating opportunities for governments, developers, and investors to take advantage of today's $30 billion carbon market. The Asian Development Bank (ADB) is also considering ways to extend CMI's services to DMCs into the future—beyond the year 2012, when current global commitments under the Kyoto Protocol ends.

Source: ADB.

sources, 67 Mt from coal-related methane, and 27 Mt from fuel switching and new technologies for power generation.[158] The PRC's Energy Conservation Law, Renewable Energy Law, and other related legislative frameworks require the Government to develop special financial incentives to promote projects in these areas.

Qinghua University's Global Climate Change Institute has estimated the financial benefits of one such project. A few years ago, there were roughly 500,000 industrial boilers in the PRC, consuming about 400 Mt of coal each year. Retrofitting 15% of these, they predicted, would require an initial, one-time investment of $205 million and result in annual carbon dioxide emissions reduction of 16.2 Mt. Fuel savings would be 7.5 Mt of coal per year, saving $226 million annually. By structuring the project under the CDM, revenue generated from the sale of CERs would provide significant extra income to the investors.[159]

India is one of the most favored sites for CDM projects globally, largely due to the enabling environment recently put in place. Although there are varying estimates of the potential for CDM projects in India, it is roughly estimated to be in the range of about 300 Mt of carbon dioxide equivalent, including 90 Mt from renewable energy sources alone.[160]

158 Ibid.

159 Szymanski, Tauna. 2002. The Clean Development Mechanism in China. *The China Business Review* 29(6). November–December. Available: http://www.chinabusinessreview.com/public/0211/szymanski.html

160 IGES, Ministry of the Environment, Japan, and Winrock International India. 2005. *CDM Country Guide for India*. Available: http://www.iges.or.jp/en/cdm/pdf/countryguide/india.pdf

Net metering. Allowing small power producers to sell excess energy can improve resource efficiency. This can be accomplished with net metering initiatives. Net metering in effect allows customers to receive retail prices for their self-generation. It allows a two-way flow of electricity between the distribution grid and customers with self-generation. When consumption exceeds self-generation, the meter runs forward, and when self-generation exceeds consumption, the meter runs backward. The customer pays only for the net amount of electricity used in each billing period, and is sometimes allowed to carry over net electricity generated from month to month. Net metering is common in parts of Germany, Netherlands, Switzerland, and US.[161]

Thailand is one of the few developing countries to have enacted a law promoting net metering. In May 2002, the Thai Parliament ratified legislation that requires state-owned electric utility monopolies to permit net metering whereby small and medium solar, wind, micro-hydroelectricity, biomass, and biogas generators that produce up to 1 MW of electricity can connect to the power grid. By ensuring market access and fair prices to small-scale renewable energy producers, ratification of the legislation has created income opportunities for rural communities and offers significant potential to reduce Thailand's dependence on imported oil and coal.[162]

161 Martinot, Eric. 2004. *Global Renewable Energy Markets and Policies*. Available: www.martinot.info/Martinot_NAR.pdf

162 Palang Thai. 2005, 1 June. *Net Metering Project Promotes Renewable Energy Generation in Thailand.* Available: http://palangthai.org/en/story/24

Policies to Promote Water Efficiency

Water management is an obvious area in which holistic, integrative policy and decision making is vitally important. In 2002, the need to improve water efficiency was recognized and given new impetus by the World Summit on Sustainable Development (WSSD). This emphasized the need for a multifaceted approach that considers wider social issues and values as well as physical and technical concerns.

Specifically, Article 26 of the WSSD Plan of Implementation sets an action target for the preparation of IWRM and water efficiency plans, and highlights the different ways of improving efficiency, by

- finding ways to maximize the value of water use and allocation decisions in and between sectors for sustainable social and economic development;
- getting the most not only out of scarce water resources but also out of other natural, human, and financial resources; and
- maximizing production efficiency, i.e., the efficiency of the processes that go into providing water when, where, and in the appropriate quantity and quality needed for a particular use.

Reforming the water sector for greater efficiency must involve decision makers at all levels working together. National and regional efforts must focus mainly on improving allocation efficiency based on the "scarcity" value of water, while local efforts must focus more on improving the technical and productive water efficiency by increasing water recycling and water saving.[163] It is crucial that efforts at all levels be mutually reinforcing and that all efforts be implemented with full participation of the agencies and stakeholders involved, including surrogates for the water needs of natural systems.

While there is no single blueprint for how to define and choose the most efficient use of water, according to the Global Water Partnership, a strategic approach to improving water efficiency would involve at least four sets of actions, each of which should be addressed in integrated water policies:

- developing the information required to make strategic choices (i.e., comprehensive water assessments),
- improving allocative efficiency at national and regional levels,
- providing an enabling environment to improve efficiency at local levels (both technical and economic efficiencies), and
- linking local to regional and national plans.

Reducing pollution discharges to water bodies is also important to increase water availability. Therefore, the following actions should also be pursued:

- investing in decentralized municipal sewage collection and treatment systems;
- enforcing regulations on industrial waste water discharge, and developing financial and economic measures to supplement regulations;
- promoting integrated pesticide management and optimizing fertilizer use; and
- passing policy measures to encourage households or communities to equip simple wastewater treatment facilities.

To address problems associated with the inefficient use of water and to create sustainable water systems, a number of countries in Asia are beginning to take a more holistic and integrated life-cycle approach to water resources planning, development, and management, termed integrated water resources management (IWRM). Under an IWRM approach, national policies take an inclusive approach to water resource management that advances a country's overall development goals, rather than the fractured practices that have been characteristic of the sector. Within this framework, decision makers can apply a set of legislative, economic, and social change instruments that encourage domestic, industrial, and agricultural consumers to use water more efficiently. With the help of donor groups like ADB (Box 4.11), most countries in the region are now pursuing IWRM, and a number of countries have improved their legislative framework, as well as their technical, financial, and administrative capacity to enforce regulations (Figure 4.6).

However, despite recent progress in the region, the effectiveness of the new laws and water policies in some countries has been limited because policy, legal, and institutional reforms are still lacking. In

163 Global Water Partnership. 2004, April. *Current Status of National Efforts to Move Toward Sustainable Water Management Using an IWRM Approach*. Project funded by the Norwegian Ministry of Environment.

Box 4.11: ADB's Support of IWRM

Integrated water resources management (IWRM) is the backbone of the Asian Development Bank (ADB) water policy, dependent on good governance, comprehensive water resource assessments, and interlinked water investments in river basins. IWRM aims to manage water and related resources in a holistic and integrated manner by promoting regional cooperation within countries as well as between riparian countries.

During the World Summit on Sustainable Development, an agreement was reached to have national integrated water management plans ready by 2005. ADB has offered to support a number of countries in responding to this challenge, aiming to balance the allocation of scarce water resources across competing priorities with the realization of economic benefits, social equity, and environmental sustainability. ADB has mainstreamed an IWRM approach into project designs in Afghanistan, Bangladesh, Cambodia, Indonesia, Philippines, Sri Lanka, Timor-Leste, and Viet Nam, and in Central Asia on a regional scale. In Central Asia, with ADB's assistance, the northern part of the Aral Sea and the Syrdarya River has been rehabilitated through framework agreements between Kazakhstan, Kyrgyz Republic, and Uzbekistan.

ADB has also helped to build and support key regional networks aiming to improve governance and initiate reforms in the water sector, including the Southeast Asian Water Utilities Network (SEAWUN), the Network of Asian River Basin Organizations (NARBO), and the network of National Water Apex Bodies. ADB has also initiated partnerships to broaden stakeholder participation to catalyze water reform activities, including the Gender and Water Alliance, Water for the Poor Partnerships in Action, and Water in Asian Cities, among others. In addition, new national water partnerships are being supported in Indonesia and the Philippines, while new subregional water partnerships are being supported in the Pacific and Central Asia, to establish water information systems.

Source: ADB.

addition, water resources development in many countries is still not integrated into the overall national development strategy and there is still no distinction between water as a resource that must be managed and water as a service for delivery. In 2003, the Global Water Partnership conducted a baseline survey of 108 countries to measure their success with IWRM. In Asia, PRC, Kazakhstan, and Kyrgyz Republic were 3 of only 11 countries in the developing world to have earned the highest rating, having "made good progress toward integrated approaches."[164]

Ongoing efforts must shift from seeking out new sources of water supplies to its appropriate allocation, management, and conservation.[165] This will require strict regulatory instruments to impose rules and limits governing water use. For these to be effective, countries need an appropriate legislative framework and the technical, financial, and administrative capacity to enforce regulations. Regulations must also be implemented with market tools and access to information to allow users the freedom to employ a range of techniques to conserve water or reduce waste disposal.[166] Another important reform involves the granting of increased decision making to local or regional authorities who are better able to manage water resources and address scarcity and efficiency issues.

A number of important policy measures are discussed below. Some other measures that are typically implemented at the local level are presented in Chapter 6.

Improving Allocative Efficiency

Scarcity forces trade-offs. While recent research and policy discussions have focused on how to increase nonconventional sources of water supply (e.g., water-loss reduction, reuse or recycling of water, interbasin transfers, and desalination of seawater), national and regional efforts must also focus on improving allocative efficiencies, including the politically difficult decision of reallocating agricultural water use to sectors with higher value-added production. Notwithstanding externality issues, economic efficiency concerns water that is consumed rather than return flows. Where there are large differences

164 Ibid.

165 ADB. 2006. *Water for All: Translating Policy into Action: Comprehensive Review of ADB's Water Policy Implementation. Final Report and Recommendation.* Manila.

166 Ibid.

Figure 4.6: Policies Promoting Increased Water Efficiency in Selected Asian Countries

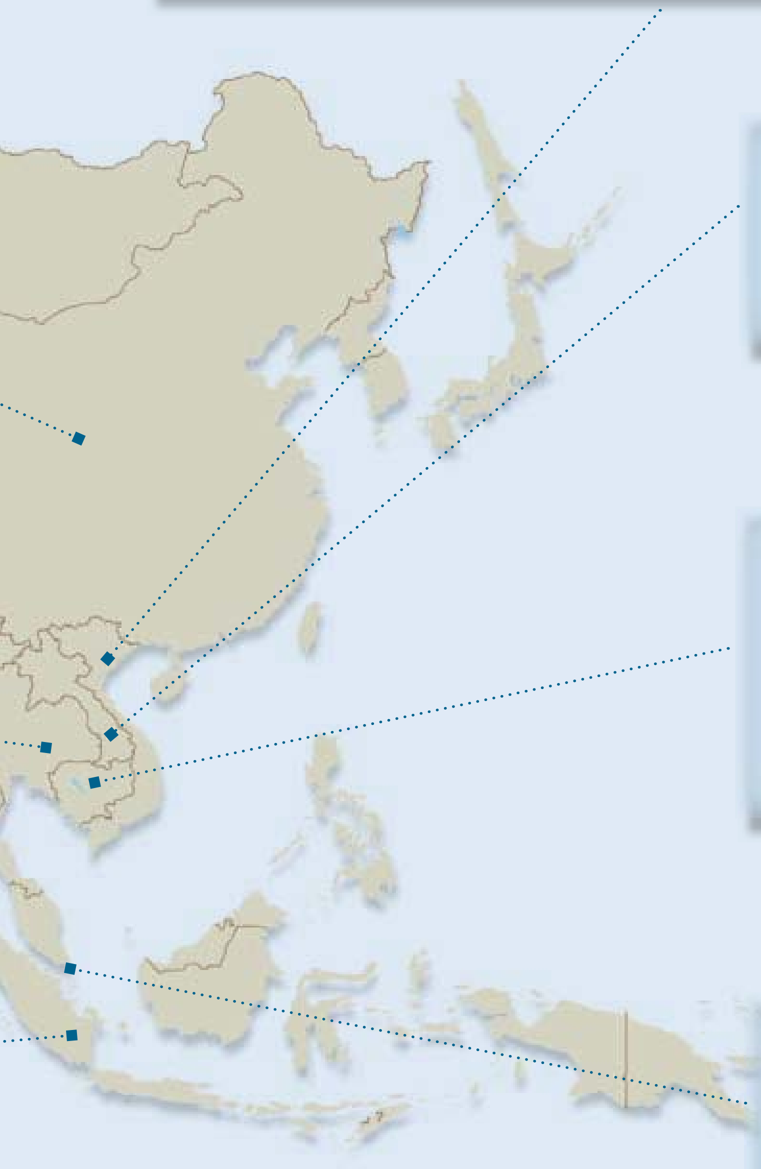
People's Republic of China : Important steps have been made toward saving water in the industrial sector. Recently six ministries, including the State Economic and Trade Commission, Ministry of Water Resources, and Ministry of Construction, jointly confirmed a 10-year goal for saving water in industrial companies. The rate of recycled water was targeted to increase from 50% in 2000 to 60% in 2005 and 65% in 2010. Eventually it might be necessary to relocate parts of water-intensive industries to more water-rich areas. Currently the heavy water-consuming industries, such as power, petrochemicals, coal, and metallurgy are mainly located in the north, which has a shortage of water resources.

Thailand: Some Asian cities have controlled groundwater use by industries through pricing mechanisms. In Bangkok, groundwater charge rates rapidly increased from 2000 to 2003, and a Groundwater Preservation Charge was introduced in 2004. The total amount of these two charges far exceeds the price of public water supply so groundwater has lost its attractiveness over surface water, especially to the industrial sector, which consumes large amounts of water.

Note: Boundaries are not necessarily authoritative.

Indonesia: New water resources law recognizes water as a natural asset with social, cultural, economic, and environmental functions, and with specific chapter and articles related to private sector participation in water management. The roles and responsibilities of the various government agencies have been clarified following the enactment of new laws and regulations, and small water utilities have been formed to serve rural communities better.

Viet Nam: The Law on Water Resources has introduced important new concepts, including integration of water management on a river-basin basis and planning for water resources according to river basins. In 2004, the Government established the General Office for River Basins Planning Management with the responsibility of monitoring and synthesizing the work of river basin organizations and coordinating efforts among ministries, line agencies, and provinces. The Government has also received donor assistance to establish river basin organizations in the three major river basins—Red-Thai-Binh, Dong Nai, and Mekong.



Lao People's Democratic Republic: The Water Resource Coordinating Committee, an apex body that can oversee policy formulation and water sector reform processes, was established under the new Water Resources Law.

Cambodia: Cambodia conducted a comprehensive water sector assessment in 2002, formulated a draft water resources strategy in 2003, and completed a water sector road map in 2004. However, a weak regulatory and institutional framework has limited effective implementation of these new laws and stalled necessary reforms.

Singapore: The city-state's successful water policy includes keeping unaccounted-for-water low, pricing water to reflect its scarcity value, and encouraging everyone, including households, communities and industries, to use and manage water wisely. The Singapore Public Utilities Board has been able to reduce the nonrevenue portion of water to less than 10% of production.

Source: ADB.

in the marginal value of water between different consumptive uses, large gains can be made by reallocating water from low-value to high-value uses.

Agriculture is the main user of water resources in the region; yet, with rapid urbanization, Asia cannot ignore a comparison of the use of water for irrigation and urban water supplies. Future demand growth in other sectors, where water use generally has a higher economic value, will lead to increased pressure for reallocation away from agriculture. However, unless decision makers are given economic incentives, water will continue to be applied to less valuable uses and users will also have less incentive to adopt water conservation practices.

For this shift to occur, some important reforms must be made. First, as countries face increased pressure to manage intersectoral transfers of water resources, they must shift away from "service charging" and toward the "scarcity" value of water, which will likely be considerably higher. Second, it will be necessary to measure volumetric consumption to implement water pricing. This is difficult and expensive in the region given that irrigators usually operate on a small scale. Third, institutional capacities and arrangements must be strengthened to determine fairly who gets what and when. This will require an ability to gather and assess information, to deliberate, to execute policies, and to answer responsibly to community members. Building this capacity is necessary for local water management and for other sustainable resource management decisions.[167]

In countries that are chronically short of water, a strategic approach to improving allocative efficiency might also involve allocating water to uses that can generate foreign exchange with which to gain access to food or other products that need large quantities of water for their production. Trading for "virtual water" allows water-scarce countries to export low water-consuming products and, in this way, make water available for other purposes.[168]

In developing plans to improve allocative efficiency, there must be close interaction among water professionals, national and local decision makers, and affected parties. Also important are such issues as food self-sufficiency, rural employment, legal framework, and effectiveness of institutions for enforcing laws and managing water resource systems.[169]

Source: ADB.

Last, allocation of an ecologically appropriate share of water to ecosystems must be an important requirement. This is especially important as the impacts of climate change accelerate in coming decades. Water management must allocate an appropriate share of the total water budget in a region to forests, wetlands, riparian and marine ecosystems, and urban green space. Such areas constitute the natural capital fundamental to maintaining a dynamic balance between human activities and the supporting biosphere.[170]

River Basin Planning

It is important to realize that water sector reforms are not merely a choice between levels of government (i.e., local versus national). Although much can be done to increase efficiency of water use at the small and large farm level, regional efforts are necessary to gain broader improvements. It is conventional now to acknowledge the logic of planning at the scale of watersheds, defined by hydrological units that cut across political borders. In many cases this means planning across national borders, because about 40% of the world's population live now in river basins shared by more than one country.[171]

167 Brennan, Donna. 2001. Water-Policy Reform Issues: An Overview. Prepared for International Workshop on Water Policy Reform: Lessons from Asia and Australia. Bangkok, Thailand. 8–9 June.

168 Ibid.

169 Ibid.

170 Falkenmark, Malin. 2003. Humans and Ecosystems Share the Same Water. *World Water Week*. No. 3. Stokholm: Stockholm International Water Institute.

171 Brooks, David. 2002. *Water: Local-level Management.*

Regional planning groups organized around watersheds, including river and lake basins, offer a broad scope for integrated water resource planning, as well as a regional context quite important for sustainable farming. There are numerous examples around the region of granting decision making at the local catchment level. Between the farm and these regional bodies are irrigation system boards and soil conservation districts.

In Viet Nam, work on establishing river basin organizations began in 1998 following the approval of the Law of Water Resources. Since then the Government has formally divided the territory into river basins for the purposes of managing their water resources. There are 15 major river basins in the scheme, eight of which are shared with the neighboring countries of the PRC, Cambodia, and Lao PDR.[172]

A catchment-based approach is also being tried in northeastern Thailand and river basin organizations have been established in more than 20 basins in the country. In the Philippines, the Government is pursuing the preparation of a water resources management plan for the Bicol river basin.

Recent surveys of river basin organizations have identified three core functions, which they mostly have in common:

- **Coordination of water management activities**. The organization assists various water sector organizations to conduct their activities in a consistent manner, so that the basin as a whole is managed better.
- **River basin planning**. The plan is the chief management tool for coordinating the management of water resources and ensuring the long-term sustainability of water resources and enterprises relying on water.
- **Conflict resolution**. The organization can bring together two or more parties with interests in the same rivers and water resources to develop solutions that all parties can accept.[173]

Ottawa: International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

172 ADB. 2006. *Initiating Integrated Water Resources Planning in the Vu Gia Basin*. Manila. Available: http://www.adb.org/Water/PDA/VIE/Interim-Report-Vu-Gia-Basin-April-06.pdf

173 Ibid.

In regional planning efforts, planners should consider more integrated, multiple-use approaches that can maximize the benefits of available water supplies. Integrated approaches involve assessing the range of water needs in collaboration with end users, examining the water sources available, and matching water supplies to needs based on the quantity, quality, and reliability required for various purposes. Such approaches commonly involve the improvement of land management practices.

Watershed planning and decision making must also take into account the needs of various ecosystems. Reforestation and restoration of wetlands and riparian habitat improve the ability of river basins to limit impacts of flooding. The restoration and conservation of natural spaces in a watershed also support conjunctive management of surface water and groundwater (page 110). Healthy forest, prairie, and riparian ecosystems contribute to recharging groundwater, which in turn supports well-planned farm land and irrigation systems. Therefore, watershed management and conservation planning need to include such activities and coordinate closely with related agencies and NGOs. In addition, national policy needs to define the value of allocation to natural system needs and require representation of ecological water uses in local and regional water management boards.

An important first step in improving water-use efficiency, and one that can be implemented on the river basin level, is determining where and how water is currently being "spent." Water accounting provides a conceptual framework for envisioning water use in a basin, sub-basin, or smaller hydrological system and identifying areas to target for improved efficiency. It is useful for getting an overview of water users in a basin, conceptualizing water allocation in the context of multiple uses of water, identifying opportunities to improve water efficiency by reducing nonbeneficial depletion and harnessing utilizable outflows, and providing a good base for stakeholder consultations and dialogue across disciplinary lines.[174]

Demand management policies will also become increasingly important. In this effort, water user associations can play a key role to

174 Global Water Partnership. 2004, April. *Current Status of National Efforts to Move Toward Sustainable Water Management Using an IWRM Approach.* Project funded by the Norwegian Ministry of Environment.

undertake irrigation scheduling or implement best farm management practices. One of the leaders in the region in this area is the Indian State of Andhra Pradesh which passed an Act to transfer the management of irrigation systems to farmers' organizations. By 1999–2000, Andhra Pradesh had more than 10,000 water user associations. The World Bank is now insisting on the formation of farmers' groups and upward revision of canal irrigation water rates under their Water Resources Consolidation projects in states like Tamil Nadu, Rajasthan, and Haryana.[175] Changes are also underway in the PRC, where the State Council has approved the establishment of water-saving and yield increasing counties, as well as irrigation districts, across the nation.

Water Pricing

Governments must consider how water pricing can serve as a tool for effective demand management and can encourage the view of water as an economic good, while ensuring that low-income households can afford basic levels of supply. Realistic water prices, when properly introduced and administered, can encourage efficient use of water, meet operational and maintenance costs, recover capital investments, generate funds for extension of services to other areas, and protect the environment by reducing the quantity of wastewater. Higher tariffs will also reduce excessive consumption and waste. These reductions will focus attention on reducing nonrevenue water (leaks, illegal connections, and metering problems).

Tariff and fee structures must balance the need to encourage efficient resource use with the need to ensure that low-income households can afford basic levels of supply, hence the frequent justification for subsidies. However, selling water below the real cost of conserving, collecting, and delivering it encourages overuse and rewards waste. Worse, subsidies are susceptible to administrative inadequacy and graft. Far from aiding the poor or politically weak, subsidies often favor the well-off and well connected.[176] For instance, "free" water may be delivered to city households by municipal pipe, but, as is often the case, only well-off households are connected to city water. The implicit subsidy confers no benefit on the poor, who face the higher prices and doubtful quality of the "private" market—most often vendors bringing small containers of water to the neighborhood.

As an example of effective national reform, the PRC, through its National Development Reform Commission, has pursued full cost recovery of water since 1998. In that year, the Government passed the National Guidelines on Water Tariffs. Since then, ongoing reforms have allowed all water supply companies and new water supply projects to be financially sustainable and capable of full cost recovery. Water supply tariff increases are now placed in the hands of local governments, removing the approval requirement of senior government, and public input on proposed tariff adjustments is also required. In addition, corporatization has become a viable option, because tariff policies play a key role in managing risk, thus attracting private sector partners. The PRC's experience shows that full cost recovery is possible. It also shows that an effective reform process takes a long time and that capacity building at all levels is necessary. The first step of drafting and implementing new laws and regulations takes a few years, and institutional reforms take longer.[177]

In addition to national actions, implementing effective water pricing also requires local leadership. The successful turnaround of the Phnom Penh Water Supply Authority (Box 4.12) shows that clean water targets can be met through a transparent environment where water utilities have sufficient autonomy, where tariffs can cover costs, where service is equitable to all, and where there is the active involvement of civil society. One of the specific lessons is that access to water does not mean that it has to be free and that the urban poor will be considerably better-off paying for safe, piped water than they would be buying water of questionable quality from private vendors. Phnom Penh's unconnected residents used to pay 1,000 riels (KR) ($0.24) per day for water bought from private water

[175] Gulati, Ashok, and Sudha Narayanan. 2001. *Subsidies and Reforms in Indian Irrigation.* Prepared for International Workshop on Water Policy Reform: Lessons from Asia and Australia. Bangkok, 8–9 June.

[176] Brooks, David. 2002. Water: *Local-level Management*. Ottawa: International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

[177] ADB. 2005. *Charting Change: Water Reforms for Full Cost Recovery in the PRC*. Available: http://www.adb.org/water/actions/PRC/charting-change.asp

Box 4.12: Improving Water Supply in Phnom Penh

With the assistance of external funding agencies and through internal reforms, the Phnom Penh Water Supply Authority (PPWSA) transformed itself into an efficient, self-financed, autonomous organization in a city still recovering from long years of war and civil strife. In the early 1990s, PPWSA was having trouble meeting its challenges. Employees were demoralized, underpaid, and underqualified. Only 13% of connections had water meters, leading to inaccurate billing. Only 28% of water production was actually sold, and the collection rate did not even reach 50%. Illegal connections were prolific and nonrevenue water was at a high 72%.

Under the leadership of Ek Sonn Chan, a young engineer who took over the helm in 1993, PPWSA began a "culture of change" and undertook a flurry of reforms. In just a few years, PPWSA became financially and operationally autonomous, achieved full cost recovery, and became an outstanding public utility in the region. Water service now covers 100% of inner city Phnom Penh and is being expanded to surrounding districts, with priority given to urban poor communities.

PPWSA now serves 15,000 families in 123 urban poor communities, giving the poor extra privileges, such as subsidized tariffs or connection fees and installment connection fees. Nonrevenue water has decreased from 72% to 8%, while bill collection is now at 99.9%. Its 147,000 connections, up from 26,881 in 1993, bring reliable and safe drinking water to all of Phnom Penh's 1 million inhabitants 24 hours a day.

Source: Asian Development Bank. 2006, August. Phnom Penh Water Supply Authority: An Exemplary Water Utility in Asia. Available: http://www.adb.org/Water/actions/CAM/PPWSA.asp

vendors. They now spend about KR5,000 ($1.19) per month for piped water (2006 rates).[178]

Water Markets

Water markets can improve efficiency by creating incentives for farmers and/or industries to save water and sell off their rights to the portions they do not use. However, many countries in Asia lack the preconditions necessary for successful water markets. Such markets require well-defined, tradable, and enforceable water rights, a strong regulatory framework, and the infrastructure necessary to transfer water from one user to another.

Water markets tend to function well in water-scarce basins where large-scale users are engaged in high-value activities. [179] Formal water markets are developing in the western US and Australia, but they are so far limited in developing Asia and mostly centered on groundwater (Box 4.13). Care must be taken to ensure that water markets do not perpetuate current problems of water overuse. In India, for instance, water scarcity has prompted some farmers to profit by selling their water instead of farming. The water they formerly used to irrigate their crops is instead pumped from their wells and trucked to nearby cities. The farmers are harvesting water rather than food and at the same time promoting a rapid drop in underground water table.[180]

178 ADB. 2006. *Phnom Penh Water Supply Authority: An Exemplary Water Utility in Asia*. Available: http://www.adb.org/Water/actions/CAM/PPWSA.asp

179 Global Water Partnership. 2004, April. *Current Status of National Efforts to Move Toward Sustainable Water Management Using an IWRM* Approach. Project funded by the Norwegian Ministry of Environment.

180 Clark, Edwin. 2007. Price of Water Rising Around the World. *Peopleandplanet.net*. 8 March. Available: www.peopleandplanet.net/doc.php?id=2969

Box 4.13: Informal Water Markets in Pakistan

In Pakistan, localized, informal markets have become an important source of irrigation for many farmers. Many areas of Pakistan have falling water tables or poor quality groundwater, and in those areas, water markets are especially important. Groundwater sales are more common in areas with canal irrigation, largely because the canals help recharge groundwater supplies, making more water available.

Private tubewells improve production by increasing farmers control over the amount and timing of irrigation. This increases yields and allows farmers to switch to higher-value crops. By making water available to those who cannot install their own wells, groundwater markets improve the equity of access to this vital resource.

However, the benefits of groundwater are not equal for water buyers and tubewell owners. Tubewell owners are primarily concerned with delivering adequate water to their own fields: if there is water left over, they may sell it to their neighbors. Consequently, purchased water is an unreliable source. Purchasing groundwater from other farmers gives farmers more control over their irrigation than relying on public canal irrigation systems alone, but less control over how much water to apply and when than if they owned a tubewell. Thus, to improve the reliability of groundwater markets, more research is needed to identify incentives for sellers and factors that promote more equitable sharing of groundwater resources.

Source: Meinzen-Dick, Ruth. 1997. Groundwater Markets in Pakistan: Participation and Productivity. *Research Report* 105. Washington, DC: International Food Policy Research Institute. Available: http://www.ifpri.org/pubs/abstract/abstr105.htm

Chapter 5. Building Institutional Capacity

Without sufficient institutional capacity and arrangements, even the most progressive legislative reforms will fail to have the desired effect, and any efforts at environmental planning can easily be compromised by political interests and mismanagement. As a result, scarce resources, such as water, materials, and energy, will continue to be used inefficiently.

As described in the previous chapter, many governments throughout Asia have issued comprehensive sets of environmental laws and regulations toward improving resource efficiency. However, it is clear that passing environmental laws and regulations is not enough to achieve the environmental quality that Asians will increasingly demand. Environmental policy regimes are only as strong as their weakest link, and that weakest link is often the institutional capacity to enforce those laws and regulations.

Despite considerable progress in many countries to strengthen their environmental institutions at the national and local levels, there remains a major compliance gap in Asia. Most countries in the region face common institutional challenges, including: harnessing political will, building adequate institutional capacity, clarifying roles among government agencies, optimizing budgetary allocations, enhancing access to justice, fostering public involvement, and disclosing information.

In the future, governments must grapple with the following questions in redesigning their institutions:

- What kinds of arrangements facilitate sustainable resource use and environmental conservation?
- How can institutions be designed that integrate external effects and account for the complex interdependencies among human and ecological systems?
- What can be learned from existing institutions to safeguard access to and sustainable use of resources?
- Are there opportunities for new coalitions among NGOs, industry, and government?

A number of common institutional issues in the region are discussed below. The Asian Environmental Compliance and Enforcement Network (AECEN) is the main source for information in this chapter. AECEN is a a regional network of national and subnational agencies from Asian countries committed to improving environmental compliance and enforcement in Asia. It is funded in part by ADB.

Coordinating Developmental and Environmental Policies

A common institutional problem arising in the region is the failure to coordinate developmental and environmental policies between the central and local governments, as well as between different sectoral interests at all levels. Few governments have adequate structures for collaboration among agencies. A principal challenge in improving resource efficiency in an economy requires a shift away from bureaucratic fragmentation to interagency collaboration and consultation.

This will require a break from the recent institutional trends. Currently, many of the legal instruments and strategies adopted by governments are entirely sectoral in approach and are implemented by ministries interested only in the specific range of activities that fall within their mandate. Thus, national ministries and regional and local agencies tend to work in relative isolation, despite the fact that they often introduce policies and invest in projects that have major impacts on the responsibilities and work of other agencies. For instance, a ministry of energy or transportation may launch a major project for production of biofuel from garbage without consulting the agency responsible for solid waste management. At other times, more than one government agency may claim competence over a particular matter, resulting in overlapping jurisdiction and institutional rivalries.[181]

In Thailand, for instance, the patchwork of laws and regulations governing environmental management has resulted in a somewhat fragmented environmental regulatory system with no single legal authority ultimately responsible for managing and protecting the environment (Box 5.1). As an example, the Pollution Control Department (PCD) within the Ministry of Natural Resources and Environment has the authority to inspect and issue administrative and civil actions against regulated point sources within its jurisdiction. However, the Factory Act of 1992 grants the Department of Industrial Works (DIW) primary enforcement authority over most factories, including imposing effluent and emission standards as part of some operating permits and issuing penalties. The result is overlapping authority between DIW and PCD, creating a situation where no single ministry is responsible for environmental compliance and enforcement of all pollution sources in Thailand.[182]

Another common problem is that ministries in charge of the environment frequently have less influence than do powerful sectoral ministries, which are more predisposed toward natural resource exploitation. This is true even in countries that have recently merged their environmental and natural resources functions, such as Malaysia, Thailand, and Viet Nam.[183]

Box 5.1: Thailand's Legal Framework and Institutions Governing Environmental Management

In response to environmental challenges over the last 2 decades, Thailand has developed increasingly progressive policy mandates that have aimed to strengthen legal frameworks, institutional arrangements, and environmental management capabilities. Thailand now has some 67 laws and regulations governing environmental and pollution control management and related issues on city planning, waste disposal, forest conservation, land allocation, groundwater usage, and irrigation. Most of these laws were enacted or amended in 1992, a watershed year in Thailand. Six ministries now share authority for the implementation of environmentally-related laws, depending on jurisdiction: Ministry of Natural Resources and Environment, Ministry of Industry, Ministry of Interior, Ministry of Public Health, Ministry of Transportation, and Ministry of Agriculture and Cooperatives.

Another major driver for improved policies and practices was the 1997 Constitution, which guarantees citizens a number of fundamental rights related to managing and conserving natural resources and the environment, participating in environmental decision making, and receiving information about projects and activities that may affect the environment. Moreover, the Constitution provides that local government has the duty to promote and maintain the quality of the environment.

As part of the Public Sector Reform Program, the government established the Ministry of Natural Resources and Environment (MoNRE), which consolidated and rationalized a wide range of environmental functions from across many ministries, and strengthened the role of regional offices to provide training and information to provincial and local governments. This new ministry now faces the challenge of creating a more unified approach to environmental management and protection. As part of its effort to implement its decentralization policy, MoNRE appointed pollution control officers from the regional and provincial offices to carry out environmental inspection and enforcement functions. Local governments eventually will play an important role in environmental compliance monitoring and enforcement.

Source: Asian Environmental Compliance and Enforcement Network. 2004. *Environmental Compliance and Enforcement in Thailand: Rapid Assessment.* Available: http://www.aecen.org/document.htm

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181 Khee-Jin Tan, Alan. 2004. Environmental Laws and Institutions in Southeast Asia: A Review of Recent Developments. *Singapore Yearbook of International Law*. Vol. VIII: 177–192. Available: http://law.nus.edu.sg/apcel/docs/Article-SYBIL3-SoutheasiaEnvironment3.pdf

182 Asian Environmental Compliance and Enforcement Network (AECEN). 2004. *Environmental Compliance and Enforcement in Thailand: Rapid Assessment*. Available: http://www.aecen.org/document.htm

183 Khee-Jin Tan, Alan. 2004. Environmental Laws and Institutions in Southeast Asia: A Review of Recent Developments. *Singapore Yearbook of International Law*. Vol. VIII. 177-192. Available: http://law.nus.edu.sg/apcel/docs/Article-SYBIL3-SoutheasiaEnvironment3.pdf

Box 5.2: ADB's Support of Institutional Development in the Environment Sector

Through technical assistance, the Asian Development Bank (ADB) is helping its developing member countries integrate environmental objectives into policy development and decision making, and establish coherent policies that confront conflicts in environmental management. ADB is also helping governments to strengthen the capacity of national environmental and sector development agencies and to introduce regulations and guidelines to ensure integrated environmental and development planning and management. Part of this assistance includes helping governments move beyond a "command-and-control" approach and toward such market-based instruments as pollution taxes, charges, and tradable permits.

Many recent technical assistance projects have emphasized capacity development, and the scope and beneficiaries of capacity building have become more diverse. For government officials, assistance is focusing on pollution taxation, environmental law, incorporation of natural disasters in fiscal processes, and strategic environmental assessment for government officials. For communities, it includes coastal natural resource management and enhanced urban waste management. For households, it includes sustainable livelihood activities, including environmental conservation, waste collection and recycling, and skills development.

Specific activities include:

- efforts to strengthen systems for pollution taxation and resource mobilization for environment and natural resources in Thailand;
- evaluation of environmental policy and investment for water pollution control in the Huai River Basin in the People's Republic of China (PRC);
- environmental monitoring and information management system for sustainable land use in Kazakhstan;
- strategic environmental assessment in the hydropower sector in Viet Nam; and
- environmental assessment procedures in the national environmental agency in Bhutan, in the Uttaranchal Power Sector in India, and in the Environmental and Social Division of the Road Development Authority in Sri Lanka.

Other ADB advisory support is promoting natural resources management in Indonesia, sound environmental management in Maldives, and energy conservation and resource management in the PRC, among others.

In 2005, ADB approved a regional technical assistance to support the establishment of the Asian Environmental Compliance and Enforcement Network (AECEN), in cooperation with the United States Agency for International Development (USAID). AECEN aims to promote improved compliance with environmental laws in Asia through a regional exchange of innovative policies and practices. It serves as a regional platform to: promote the development and implementation of improved environmental laws, regulations, and institutions; strengthen practitioner's capacity through specialized training and tools; and facilitate regional sharing of best practices and information.

Source: ADB.

To address these problems, any efforts to improve institutional development and capacity development must be broad-based. They must include authorities in charge of environmental protection and sustainable development, authorities in charge of general coordination and integration among different sectors—agriculture, construction, education, environment, finance, health, industry, and transportation—and also concerned sector authorities, such as those in charge of water resource management or energy planning. The same range of agencies needs to be involved at local and regional levels.

Laws that promote resource efficiency should provide relevant agencies (environmental or otherwise) with clearly-defined mandates, responsibilities, and resources to protect public health and the environment and to promote efficiency improvements through regulatory or financial incentives, technical assistance, or information-based measures (Chapter 4).

An agency's regulatory authority should encompass the full range of powers and responsibilities, including standard setting, permitting, monitoring and inspection, investigation, and enforcement actions. Since these powers and functions are interconnected, incomplete mandates can seriously limit the agency's capacity to ensure compliance. The roles and responsibilities of the principal agency should not overlap or conflict with those of other government agencies.

In addition, the principal agency should have the institutional autonomy to develop and implement its resource efficiency program free from political intervention or external pressure related to economic development or other government or private sector priorities. The credibility of the agency will depend on the public's perception of its independence.

Where separate government agencies have complementary responsibilities, interagency cooperation is crucial for effective enforcement of environmental requirements. To ensure effective cooperation and coordination, a country's principal environmental agency should work with all related agencies: agriculture, economic development, energy, health and safety, land-use planning, natural resources management, and transportation, as well as criminal investigation, customs.

In coordinating with other agencies, environmental agencies should address gaps and overlaps in authority, and ambiguity in operational roles. Possible interagency cooperation mechanisms can include interagency agreements that establish clear coordination procedures, joint research programs; and multi-agency committees or task forces. Sharing information among national and local agencies can also be an effective strategy for understanding their interlinked responsibilities and facilitating coordinated decision making. Some governments, in some cases with help from donor groups like ADB (Box 5.2), have taken steps to strengthen coordination between departments with innovated mechanisms.

For instance, in the PRC, Chongqing municipality engaged in a series of campaign-style joint enforcement and comprehensive environmental management activities to boost environment quality. To define clear responsibilities and enhance supervision over key problems and projects, the city in 2005 initiated four campaigns: Blue Sky, Clear Water, Green Land, and Serenity. They also set up a task force headed by the vice mayor involving eight government agencies, and established an inspection team with the involvement of the General Office of the City Hall, Office of Inspection, Bureau of Supervision, and Environmental Protection Bureau to regularly check progress of the four campaigns and hold accountable those who failed to achieve set tasks. With concerted efforts, the environment in Chongqing improved dramatically. In 2006, the State Environmental Protection Administration announced the appraisal of environmental quality of 47 key cities, among which Chongqing ranked in the middle, as against being last in 2004.[184]

Devolving Authority to Local Governments

Another trend around Asia involves the granting of increased decision making to local or regional authorities who are better able to manage resources and address scarcity and efficiency issues. In Viet Nam, for instance, the Law on Water Resources has introduced important new concepts, including integration of water management on a river basin basis and planning for water resources according to river basins, as discussed on page 90.

Such devolution, while generally favorable, comes with significant challenges in the transition. A common scenario is that national-level agencies are reluctant to devolve regulatory authority, while local governments are characterized as incapable of properly exercising their increased responsibilities. The Philippines offers a good example. The country has strengthened pollution control laws by passing new or amendatory legislation on various issues—such as toxic and hazardous waste management (1990), clean air (1999), ecological solid waste management (2000), and clean water (2004)—and has transferred much authority and responsibility over environmental management functions from national agencies to local governments. Each new law has adopted different regulatory strategies, giving varied powers and responsibilities to existing entities, such as the Department of Environment and Natural Resources (DENR), local government units (LGUs), and specially-constituted multisectoral management bodies. While implementation mechanisms are slightly different under each law, implementation of the new laws has not always been smooth.[185]

184 AECEN. 2006. *Survey on Status Quo and Problems of Environmental Compliance and Enforcement in China: Case Study of Chongqing.* Available: http://www.aecen.org/document.htm

185 AECEN. 2004. *Environmental Compliance and Enforcement in the Philippines: Rapid Assessment*. Available: http://www.aecen.org/document.htm

For instance, the new ecological waste management law requires the conversion of unsanitary dumps into "controlled dumps" and eventually to sanitary landfills, but there are little funds available to implement this. Instead, local governments are expected to generate their own funding through fees, which is not happening in most places. The DENR is pushing local governments to meet the requirements for proper disposal or it will initiate cases against violating local government. However, many local government officials are unaware of their responsibilities under the law, and many of the obligations of LGUs require technical capability they do not currently possess.

Recent laws in the Philippines also have the tendency to create specialized multisectoral bodies to address specific issues, among these are the governing board for airsheds (under the Clean Air Act) and the governing board for water quality management areas (under the Clean Water Act). Each of these bodies requires membership and participation from national agencies, such as DENR, and LGUs located within the defined management areas. An LGU can potentially be a member of several of these bodies that have overlapping geographical boundaries.

Multistakeholder management or policy bodies have the advantage of broad support from all sectors. However, a number of bodies have been created with the same memberships or representations. Some of these bodies could potentially be merged because their functions are performed by the same set of members clothed with different mandates. DENR plays a critical role because it invariably co-chairs and provides secretariat support for these special bodies. These are additional duties for the agency without a corresponding increase in budget or personnel.

Despite the problems encountered in decentralizing environmental functions, countries like the Philippines should be applauded for their efforts, and national or central governments should continue to grant increased powers to regional or local authorities. For some functions, regional or local authorities have a more complete understanding of conditions and needs, and can better respond to program needs within a national framework. Overall, devolution and autonomy can foster increased efficiency and equity.

The challenge is to strike a balance on what responsibilities are retained at the national level and what are devolved to local levels. At a minimum, national agencies should retain authority on national standard-setting and policy making and issues related to transboundary pollution. National agencies should also retain ultimate enforcement powers over responsibilities devolved to local authorities.

However, functional responsibilities and tasks of national environmental agencies should be completed by the lowest competent unit, in keeping with the principle of subsidiarity. The responsible environmental national agency should also build and strengthen the capacity of subnational units and provide the necessary oversight, implementation support, and coordination, including policy guidance, staff training, reporting results, and establishing appropriate funding and reporting mechanisms.

Lack of Resources

According to recent estimates, government spending on environmental protection amounts to less than 1% of GDP in Asia and the Pacific. Japan, with an average annual outlay of 1.8–2.0% of GDP, spends the most on environmental protection, followed by the Republic of Korea with 1.3–1.6%, Singapore with 1.2–1.5%, and Taipei,China, with 1.0–1.2% of GDP.[186]

At the other end of the scale, Viet Nam spends only about 0.1–0.3% of GDP, and PRC, Indonesia, and Philippines, 0.5–0.7%. Malaysia and Thailand both invest almost 1% of GDP on the environment. India's expenditure is not fully documented because of the fragmented structure of government, but is believed to be less than 1% of GDP, despite a markedly higher priority accorded to the issue since 1992.[187]

In Viet Nam, despite the recent enactment of important environmental policies and legislation, the effectiveness of the Government's environmental protection program and its enforcement efforts are severely hampered by limited institutional capacity, lack of technical expertise, and insufficient funding. Under the present budget, the agencies are hindered in effectively repairing and upgrading environmental

186 Boyd, Alan. 2002, 26 November. *Environmental Cost of Asia's Development*. Asia Times Online. Available: http://www.atimes.com/atimes/Asian_Economy/DK26Dk01.html

187 Ibid.

infrastructure projects, as well as investing in strengthening technical skills of officials. Insufficient resources also prevent investment in supporting facilities to upgrade production equipment and apply advanced technology to treat wastes by domestic enterprises.

Environmental protection agencies also continue to experience a shortage of personnel in charge of environmental protection, particularly at the local level. According to a Ministry of Environment and Natural Resources Report presented at the National Environment Workshop in April 2005, Viet Nam has only some 500 officials in charge of state management over environmental protection—a very small number of officials compared to neighboring countries. In general, the personnel also lack strong environmental backgrounds and training to support program implementation. In addition, Ho Chi Minh City has 200 officials in charge of environment management, including full-time and part-time employees in both the city's and district-level natural resources and environment departments. This number of environmental officials is simply too small to provide adequate environmental management and protection to a city of nearly 8 million people.[188]

As a result, according to the *2005 Environmental Sustainability Index Report,* Viet Nam's ability to protect its environment ranked lowest of the 10 Association of Southeast Asian Nations (ASEAN) countries and 98th among 117 developing countries.[189] This sustainability index benchmarks a nation's capacity for environmental stewardship based on 21 evaluation indicators, including carbon dioxide and greenhouse gas emission, water quality, air quality, land, environmental capacity, science and technology development, natural resources management and capacity, and capacity to reduce population pressure.

In India, a recent assessment that identified human and institutional capacity limitations at both the central and state levels found that the human resources structure in most state pollution control boards (PCBs) is heavily dominated by nontechnical staff. For example, in the Andhra Pradesh PCB, there are only 88 technical staff, 25% of the total, resulting in a situation where one technical person is required to monitor 100 polluting installations. Most of the professionals are engineers, with very few legal or policy experts. In an extreme case, the Arunachal State PCB has no staff of its own and is run by personnel of the State Department of Environment and Forests.

Even in many states where PCBs are doing well financially (e.g., Maharashtra, Uttar Pradesh, Tamil Nadu), they cannot get approvals from the respective state governments to hire more staff. In addition, the low level of professional training contributes to the lack of institutional capacity. There is no formal procedural or technical training in any state PCB, nor are there minimum training requirements specified by the central PCB. Less than 1% of total state PCB expenditure goes to staff training.[190]

Some countries are increasing their budget allocations for environment protection, beyond the regional norm of less than 1% of GDP. The PRC, for instance, is projected to increase spending on environment to 1.5% of GDP during the next 5 years.[191]

188 AECEN. 2005. *Environmental Compliance and Enforcement in Vietnam: Rapid Assessment*. Available: http://www.aecen.org/document.htm

189 Ibid.

190 AECEN. 2006. *Environmental Compliance and Enforcement in India: Rapid Assessment*. Available: http://www.aecen.org/document.htm

191 Ahmad, Nessim J. 2005. Making Profits, Protecting Our Planet: Corporate Responsibility for Environmental Performance in Asia and the Pacific. Speech at the 6th Asia-Pacific Roundtable for Sustainable Consumption and Production. Melbourne, Australia. 10 October.

Chapter 6. Supporting Local Action

The critical role of local authorities in promoting resource efficiency should not be overlooked. Because local governments have jurisdiction over the large populations living and working within their boundaries, they are in a good position to influence the habits that cause high resource consumption.

This chapter looks at some important ways in which local governments are improving resource efficiency. One key lesson is that local governments must not view lack of resources or national support as an excuse for inaction. They can take immediate action by encouraging public participation and promoting community-based programs. Moving forward, the best local solutions will likely involve the application of appropriate technology combined with local insight. Technology alone, however, is meaningless without fair and effective local management.

Local initiatives are most effective when supported by comprehensive national legislation and national programs, especially those that provide incentive mechanisms for local governments.[192] Community-based organizations and NGOs also play an essential role in local programs, especially in the areas of public awareness and education. Meanwhile, international agencies and organizations can do their part by coordinating financial and technical support and by fostering collaboration to provide a common platform to share ideas, experiences, and knowledge.

Local Solid Waste Management

In the economically more advanced urban centers of Australia; Hong Kong, China; Japan; Republic of Korea; and New Zealand, local leaders are finding that integrated approaches to waste management offer economic benefits through cost savings, income generation, new employment, and promotion of new business opportunities. Pursuing integrated approaches can help maximize the economic potential of resource recovery. Some of the key factors that affect this potential are the cost of the separated material, its purity, its quantity, and its location with regard to the intermediate and final processing facilities. The costs of storage and transport are also major factors.[193]

New practices such as volume-based collection fees and curbside collection, along with public education, have resulted in a high degree of waste reduction, separation at source, and recycling. For instance, the Republic of Korea extended a volume-based fee system to all towns in 1995, which helped to decrease the amount of waste for disposal by 20–30%.[194] These measures can affect public attitudes about the importance of the 3Rs (Box 6.1).

In developing countries, however, most urban areas still struggle to deal with their garbage. In the cities of developing Asia, 30–60% of the solid municipal waste that is generated is not collected and is instead dumped indiscriminately in streets, drains, rivers, and ravines,

[192] Kitakyushu Initiative for a Clean Environment. 2006, June 23. International Workshop on Local Initiatives Addressing Transformation of Lifestyles Toward Achieving Sustainable Development in Asia and the Pacific. Tokyo, Japan. Summary of Discussions.

[193] Zurbrügg, Christian. 2002. Urban Solid Waste Management in Low-Income Countries of Asia: How to Cope with the Garbage Crisis. Presented to the Scientific Committee on Problems of the Environment (SCOPE) Urban Solid Waste Management Review Session. Durban, South Africa. November.

[194] UNEP. International Environmental Technology Centre. 2002, March. *International Source Book on Environmentally Sound Technologies (ESTs) for Municipal Solid Waste Management (MSWM).* Available: http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/RO/asia/topic_a.asp

Box 6.1: Successful Recycling Program in Nagoya, Japan

In Nagoya City, the 2.2 million residents generated 1 million tons of solid waste per year and faced a waste crisis when a proposed landfill was cancelled and the city's incinerator closed. Citizens were challenged to work together to reduce waste generation by at least 20%. Through recycling and charging businesses for the collection of general waste, this goal was achieved within one year. As neighborhood associations and citizens' groups became more involved in recycling, purchase patterns started to change and the waste generated fell even further. The current plan is to reduce waste generation to 620,000 tons by 2010 and to reduce the waste sent to landfills to 10% of the 2000 level. As shown in Nagoya, awareness and information campaigns can help change attitudes toward the environment and can result in environmental, economic, and social benefits.

Source: Asian Development Bank. 2005. *Asian Environmental Outlook: Making Profits, Protecting Our Planet.* Manila.

while the collected waste is often disposed of in unsafe, open dumps. Inadequate waste disposal creates serious environmental problems that affect human health and cause serious economic and other welfare losses. These problems include contamination of surface water and groundwater through leachate, soil contamination through direct waste contact or leachate, and air pollution by burning of wastes.

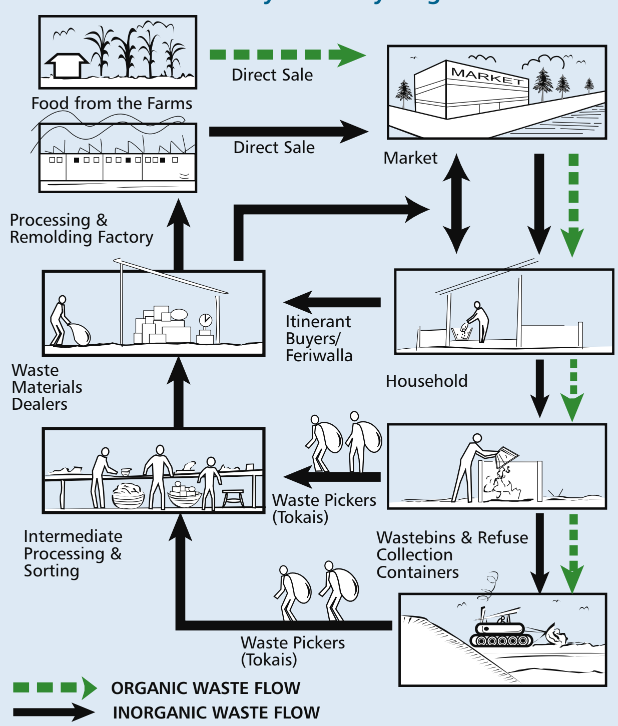
Unfortunately, many cities that are starting to address their waste problems are turning to costly conventional solutions to maximize refuse collection and upgrade disposal facilities, while ignoring lower cost and socially desirable options that incorporate resource efficiency. Experience in many cities has shown that conventional solutions fail to consider the profound differences between developed and developing countries, such as consumptions patterns, available capital, and institutional capacity (see Chapter 7 for a discussion of conventional solid waste management versus systems that given greater attention to resource recovery and recycling).[195]

The cities that have enjoyed the most success in managing their waste have typically combined conventional solutions with affordable and community-based solutions that work well in a developing world context (Table 6.1). Local programs, often supported by NGOs, help create jobs, protect the environment, promote community participation, and encourage and support entrepreneurship.

Successful programs in developing cities must also consider the contribution of informal waste collectors and resellers, often called waste pickers

Source: C. Visvanathan.

Figure 6.1: Role of the Informal Sector in Materials Recovery and Recycling



Source: Md. Maqsood Sinha, A.H. 2006. *Community-based Solid Waste Management through Public-Private-Community Partnerships: Experience of Waste Concern in Bangladesh.* Presentation in 3R South Asia Expert Workshop. Kathmandu, Nepal, 30 August.

195 Medina, Martin. 2002. *Waste Picker Cooperatives in Developing Countries*. Mexico: El Colegio de la Frontera Norte.

Table 6.1: Examples of Community-Based Solid Waste Management Projects in Asia

Country	Project
Indonesia	A number of cities have introduced organized citizen participation and involvement in primary collection schemes. In Yogyakarta, neighborhood units use handcarts for house-to-house collection. These play a significant role in the city's solid waste management system.
Lao People's Democratic Republic	In 2003, a nongovernment organization introduced solid waste collection to 11 villages with a population of 12,000 people. The project proposed to collect and dispose of municipal solid waste from the local market and to promote hygienic practice.[a]
Nepal	In the city of Lalitpur, the Women's Environment Preservation Committee, supported by the Danish International Development Agency, started a pilot project to promote source segregation and composting. The project is already servicing 500 households with primary collection. The sweepers sort out the recyclables and sell them to waste traders, while the organic waste is composted. The organization sells 1,200–1,500 kilograms of compost monthly. This method has spread extensively in Nepal.[a]
Philippines	As part of the Asian Development Bank's Poverty Environment Program, the Smokey Mountain Remediation and Development Project aims to reduce the health risks of poor communities due to exposure to remaining wastes in the old dump site while improving the livelihood of those who rely on waste as source of income.
Sri Lanka	As part of the Environmental Pioneer Brigade Programme, school children are educated about the environment to help raise awareness and change behaviors. In 2000, the program was expanded from 1,850 to 3,005 schools.[b]
Thailand	In Nonthaburi, city officials started a campaign to reduce waste by public participation and public awareness in communities, schools, department stores, apartments, and temples. Presently, solid waste generation is 350 tons/day and waste separation is 59 tons/day. (Recycling rate 17%). Nonthaburi built composting facilities, separated organic solid waste from municipal waste, and produced fertilizer for agricultural use.[c]

[a] Glawe, U., C. Visvanathan, and M. Alamgir. 2005. Solid Waste Management in Least Developed Asian Countries – A Comparative Analysis. International Conference on Integrated Solid Waste Management in Southeast Asian Cities. 5–7 July, Siem Reap, Cambodia.

[b] United Nations Economic and Social Commission for Asia and the Pacific. Available: http://www.unescap.org/DRPAD/VC/CONFERENCE/ex_lk_16_epb.htm

[c] Kitakyushu Initiative for a Clean Environment. 2006. International Workshop on Local Initiatives Addressing Transformation of Lifestyles Toward Achieving Sustainable Development in Asia and the Pacific. *Summary of Discussions*. 23 June, Tokyo, Japan.

or scavengers. Well adapted to local conditions, the informal sector uses labor-intensive methods and simple equipment, such as push carts, and can collect waste in places where conventional trucks owned by local governments or large companies cannot enter, especially in low-income neighborhoods, slums, and squatter settlements.[196]

As shown in Figure 6.1, informal waste collectors gather materials at every stage of the waste management process, for example:

- Informal collectors purchase source-separated recycles from residents or from collection crews, as is common in the Philippines and Thailand.
- In areas not served by formal collection systems, informal refuse collectors charge a fee to residents to pick up their garbage and then retrieve the recyclables it contains.
- In many cities, collectors pick up litter from streets, public places, and even canals and rivers.
- In some countries, waste pickers still live and work in municipal open dumps, sorting out recyclables.[197]

From informal collectors, recyclable products typically enter a chain of dealers who perform useful services to industry by further sorting and processing materials and then selling them in the amounts that industry demands. However, the existence of these

[196] Zurbrügg, Christian. 2002. *Urban Solid Waste Management in Low-Income Countries of Asia: How to Cope with the Garbage Crisis*. Presented at the Scientific Committee on Problems of the Environment (SCOPE) Urban Solid Waste Management Review Session. Durban, South Africa. November.

[197] Medina, Martin. 1999. Informal Recycling and Collection of Solid Wastes in Developing Countries: Issues and Opportunities. *Working Paper* No. 24.Tokyo: United Nations University and Institute of Advanced Studies.

Box 6.2: ADB Support of the Informal Sector in the Lao People's Democratic Republic

The Solid Waste Management and Income Generation for Vientiane's Poor Project aims to improve the living conditions of the poor household and waste pickers in Vientiane through an improved sanitary environment, better access to waste collection services, and improved standards of living through acquisition of entrepreneurial skills.

- The solid waste infrastructure improvements component aims to improve conditions at the municipal landfill site, establish a waste pickers' multipurpose center (WMC), and improve management capability of the municipal landfill authority. The WMC will provide a sorting area, recycling facilities, and training and administration rooms.
- The community-based solid waste management component aims to enable communities to participate actively in solid waste separation, collection, and recycling. A community-based fee collection system will be introduced, whereby the community will bear the cost of collection. Actual site selection will be based on community willingness to contribute resources.
- The income-generation and entrepreneurship development component comprises training and skills development in waste recycling, marketing and entrepreneurship, composting organic waste and vermiculture, and accounting and bookkeeping.

Source: ADB.

dealers can lead to exploitation of waste pickers, especially in cases of a monopolistic market.[198]

Despite the lack of data at the national level, various studies have highlighted the economic importance of informal collection and recycling activities. In the late 1980s, it was estimated that, in Bangkok, Jakarta, Kanpur, Karachi, and Manila, scavenging saved each city an average of at least $23 million per year from reduced imports of raw materials and reduced need for personnel, facilities, and equipment for collection, transport, and disposal.[199] In Indonesia, waste pickers reduce by one third the amount of garbage that needs to be collected, transported and disposed of, with the benefit of extending the life of disposal facilities.[200] And in Bangladesh, the entire operation of plastic recycling employs a chain of actors from scavengers to brokers. Economically, this sector generates over 22,000 jobs and saves foreign exchange of $52 million per year by avoiding import of virgin plastics and resins. Scavenging also renders significant environmental benefits, because recycling materials saves energy and water and generates less pollution than obtaining virgin materials.

Box 6.3: Health and Safety Issues of Scavenging

While informal source separation and recycling provides a livelihood for many people in the developing world, this sort of recycling presents health and safety issues to those involved. The scavengers that sift through the waste are exposed to clinical material, fecal matter, and hazardous wastes. In places like Phnom Penh, many waste pickers are children below 18 years (51% in 1998), both in the streets and in the dumpsites. In addition, working conditions and safety procedures employed in recycling operations are poor and workers are exposed to unreasonable risks—risks that the developed countries would not accept or allow in their own nations.

Source: United National Environment Programme, International Environmental Technology Centre, and ASEAN Working Group for Multilateral Environmental Agreements. 2002. *State of Waste Management in South East Asia*.

Source: ADB.

198 Medina, Martin. 2005. Waste Picker Cooperatives in Developing Countries. Paper prepared for WIEGO/Cornell/SEWA Conference on Membership-based Organizations of the Poor, Ahmedabad, India. January.

199 Baldisimo, J. 1988. Scavenging of Municipal Solid Waste in Bangkok, Jakarta and Manila. *Environmental Sanitation Reviews* No. 26. Bangkok: Asian Institute of Technology.

200 Ibid.

Unfortunately, most authorities in Asian countries do not fully realize the social, economic, and environmental benefits that informal waste collectors provide, and development banks tend to ignore their role, although ADB has recently initiated a number of projects that focus on the social aspects of solid waste management (Box 6.2). Consequently, the informal sector has usually overlooked when designing solid waste management policies and plans.

When the informal sector *is* considered, the focus is often on its negative aspects, particularly on health and safety issues (Box 6.3), and the objectives are to eliminate or punish them.[201] Removing squatters from landfills without offering them alternatives for survival creates a conflict between the economic goal of poverty reduction and the social goal of healthful habitat for the poor.[202]

Despite indifferent or negative national policies toward waste pickers, some cities started taking steps to integrate informal waste collectors into formal solid waste management programs. As part of this shift, the formation of waste picker cooperatives has gained impetus in Asia over the last few years to help waste pickers organize themselves, obtain higher incomes, and improve their working and living conditions. Such programs have job creation and poverty reduction benefits.

At the same time, local waste management services and environmental conditions can also be improved through better integration of the formal and informal sectors. For example, if cities offer waste pickers incentives to bring the waste they collect to transfer stations, waste pickers are less likely to dump their collected waste illegally in vacant lots, river banks, or ravines. At the same time, the city avoids the need to purchase collection trucks and service is improved, particularly in slum areas.[203]

Perhaps the most successful program in the region is being implemented in Bangladesh. In 1995, the NGO Waste Concern, with the help of UNDP, started a pilot composting plant in Mirpur, Dhaka on land donated by the Lions Club. Making use of the existing network of waste pickers and of simple technology, Waste Concern was able to demonstrate the benefits of a community-based approach.

With support from the government, Waste Concern replicated their model (Box 6.4) in four other poor communities around the capital. After this initial replication, it took 5 more years before the biggest hurdle for more widespread replication—access to land—was finally cleared. Dhaka's Municipal Corporation and Public Works Department provided government land on which to establish more community-based composting plants, and then the project took off.[204]

Waste Concern was able to initiate a large-scale (700 tons/day) composting plant in Dhaka, producing 50,000 tons of organic fertilizer per year. The organization looks forward to this project's reducing 1 Mt of GHGs over 8 years under the clean development mechanism.[205] International donors are now supporting the implementation of similar schemes in 20 cities and towns in Bangladesh.[206] The projects are small in scale (1–5 ton capacity), labor intensive, use simple technology (aerobic windrow system) and are combined with primary solid waste collection services.

Another successful program was implemented in Madras, where the NGO EXNORA created a waste collection program in low-income neighborhoods to formalize scavenging activities. Under the program, waste pickers were incorporated as waste collectors (called "street beautifiers"), while communities obtained loans to purchase tricycle carts to be used as refuse collection vehicles by the street beautifiers. Before disposal, the street beautifiers recover the recyclables contained in the collected wastes. Residents pay $0.30 per month for having their refuse collected and these fees are used to pay back the loans and to pay the street beautifiers' salaries. About 900 collection units involving waste pickers exist in slums, as well as in middle- and upper-

201 Medina, Martin. 2002. *Waste Picker Cooperatives in Developing Countries*. Mexico: El Colegio de la Frontera Norte.

202 Gonzales, Eugenio. 2003. From Wastes to Assets: The Scavengers of Payatas. *Conference Paper Series* No. 7, Tagaytay City, Philippines: Political Economy Research Institute and Center for Science and the Environment. January.

203 Footnote 201.

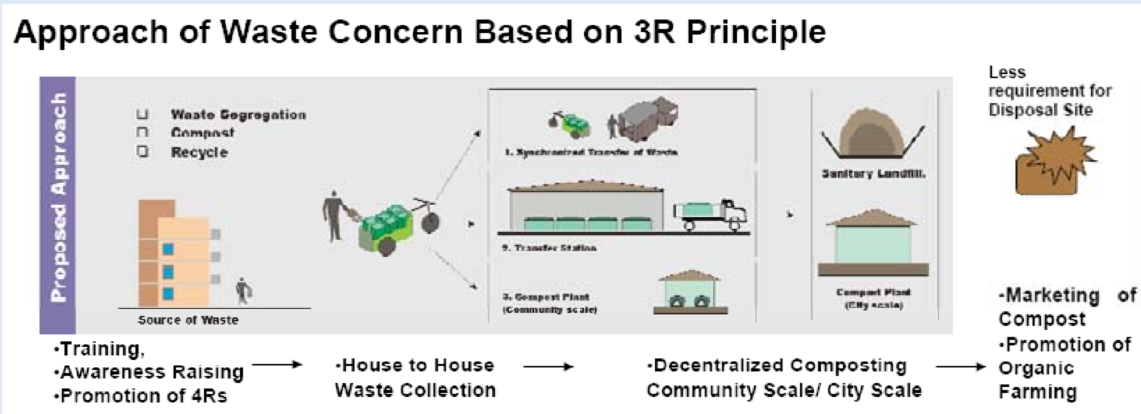
204 Ashoka. *Cash for Trash: Solving Dhaka's Waste Problems*. Available: http://www.ashoka.org/files/Cash%20for%20Trash.pdf

205 3R Knowledge Hub Secretariat. 2007. *Gap Analysis in Selected Asian Countries*. Bangkok: Asian Institute of Technology.

206 Glawe, U., C. Visvanathan, and M. Alamgir. 2005. Solid Waste Management in Least Developed Asian Countries—A Comparative Analysis. International Conference on Integrated Solid Waste Management in Southeast Asian Cities. Siem Reap, Cambodia. 5–7 July.

Box 6.4: Model of Waste Concern Based on the 3R Principle

Every four to six houses in a slum share a barrel for composting kitchen waste. A group of around 120 former waste pickers employed by Waste Concern collects the organic household waste from local households using small, bicycle-driven collection carts. The waste is then transported to community processing centers and transformed into compost over a period of 55 days. This top quality compost can be sold for up to $50 for a 50-kilogram bag.



Sources: Ashoka. *Cash for Trash: Solving Dhaka's Waste Problems*. Available: http://www.ashoka.org/files/Cash%20for%20Trash.pdf; Waste Concern.

income neighborhoods. The program has dignified waste picker activities, raised their earnings, reduced littering, increased refuse collection, and contributed to a cleaner urban environment.[207]

Local Efforts to Improve Energy Efficiency

Municipalities around the world demonstrate that when cities plan and develop with EE in mind, per capita energy consumption for municipal, residential, and transportation needs can be cut significantly. While they cannot legislate national carbon taxes or mandate nationwide changes in the fuel mix for electricity, local government decisions can either mitigate or exacerbate unsustainable energy practices that waste money, cause air pollution, and ultimately contribute to climate change.[208]

First, governments design and manage public assets and operations, such as buildings and facilities (e.g., power plants, water supply and treatment facilities, recreational facilities, street lighting), which directly consume large quantities of fuel and electricity. For instance, they either own or control gas and electricity utilities and district power operations, or they purchase power from private

[207] Medina, Martin. 2005. Waste Picker Cooperatives in Developing Countries. Paper prepared for WIEGO/Cornell/SEWA Conference on Membership-based Organizations of the Poor, Ahmedabad, India. January.

[208] Yienger, James, Lizbeth Brown, and Nancy Skinner. 2002. Experiences of ICLEI's Cities for Climate Protection Campaign (CCP): A focus on Asia. Proceedings of IGES/APN Mega-City Project. Kitakyushu Japan. 23–25 January.

utilities; thus, they have the opportunity to influence the efficiency of power production and the source of fuel used. Following are some examples from around the region.[209]

- Puerto Princesa, Philippines, incorporated energy savings features into a socialized housing project called the Green Homes Project. With a goal of 1,000 units, the project will save 1.9 pesos (P) million per year (about $50,000) and reduce carbon dioxide emissions by 167 tons per year. Puerto Princesa has also implemented EE projects in public buildings, urban greening projects, traffic management, and bicycles for police officers.
- Bhopal, India, reduced energy bills for water pumping by replacing pump sets and installing capacitors at eight major pumping stations and at 400 small pumping units. The city implemented a corresponding maintenance program to reduce leaks and friction. Bhopal also removed redundant fittings in high-mast lighting at intersections, installed daylight sensors to automate streetlight operations, and halved the wattage of street lighting in residential colonies.
- Ahmedabad, India, created a special Energy Cell, with assistance from the Alliance to Save Energy, devoted to preparing proposals for EE. So far, the city has upgraded its water pumping operations by replacing piping, reducing water loss and friction, and improved power quality of motors. These upgrades saved the city 4.4 million rupees (Rs) (over $90,000) and decreased peak demand for energy by 11%.
- Cebu, Philippines converted 700 mercury vapor lamps to high-pressure sodium resulting in a carbon dioxide reduction of 150 tons per year, an annual cost savings of P1.17 million (about $28,000), and energy savings of 672 kWh. Cebu also initiated waste minimization strategies, vehicle efficiency and maintenance clinics, partnerships with industries, and EE in city building programs.

[209] Ibid.

Box 6.5: Energy Code in Hong Kong, China

Building energy codes have been upgraded in a number of Asian cities and countries recently. In Hong Kong, China, for instance, lawmakers passed in 2003 a performance-based building energy code using a total energy budget approach. The Government developed a software tool for assessing the environmental impact, energy use, and cost implication of building development and, in doing so, integrated life-cycle analysis and costing into decision making for commercial building development. Because commercial buildings are responsible for a third of the city's total energy end-use, such a program has the potential to save a significant amount of energy.

Source: Asia Pacific Economic Cooperation (APEC). 2005. December. *APEC Energy Overview.* Tokyo: Asia Pacific Energy Research Centre, Institute of Energy Economics..

Local governments also often frequently have regulatory influence or responsibility for building codes, which can include EE standards and recommended technologies (Box 6.5). Such technologies may include cogeneration[210] and tri-generation[211] for building applications, district heating and cooling systems, ground heat pump systems, energy efficient lighting and windows, energy management controls, and variable speed-drive motor systems for fans and pumps.

Importantly, local governments also control local land-use policies, which determine where buildings and development are located and the mix of uses that are allowed. Zoning, permits, and municipal by-laws affect energy use by affecting residential and commercial density, residential access and proximity to services, transit accessibility, and other factors.

In the transportation sector, local governments make or influence infrastructure decisions and investments, such as roads and transportation or transit systems. In so doing, they influence travel mode choices, a significant determinant of transportation energy use. Local planners should consider the relative resource efficiency of highway versus rail-based transportation systems. For each option, the costs of total urban and rural land

[210] A process in which an industrial facility uses its waste energy to produce heat or electricity.
[211] Includes energy for cooling systems in addition to electricity and heat.

Box 6.6: Integrated Transportation Planning

Creating short-term strategies is useful for increasing the energy efficiency and lowering the greenhouse gas emissions of road vehicles. However, long-term transportation planning requires a holistic approach emphasizing intermodal, rail-based transit systems and not following the errors of western transportation planning. Rail-based transport is far more efficient and cost effective than road transport. Consider the following:

- Efficiency of total resource use per kilometer traveled (for both people, and materials and products) is roughly 7–12 times greater for rail-based systems than for road systems.
- Highway construction costs are almost six times the costs of rail construction, with a similarly greater demand on material and energy resources.
- Highway transport requires approximately three times the land that rail-based systems use. The total land required for the auto and truck infrastructure in cities and towns makes rails even more cost effective in terms of land use.
- Up to one fourth of urban and suburban land in the United States is devoted to vehicle transport. This includes freeways, streets, alleys, home garages, body shops, gas stations, parking garages (lanes, lots), car dealers lots, and wrecking yards.
- The cost of rail vehicles is roughly 15% that of road vehicles to move the same number of people.
- In terms of the energy demand for operation, highway transport uses over five times as much energy as rail systems.

A highly resource-efficient transportation service would, therefore, be rail-based and link other modes of transportation into a seamless system. Information systems would enable travelers to schedule and pay for entire trips, perhaps being picked up at home by a van, transferred to a rail or light-rail station, and at the other end, move to different destinations via a rental car. Travel time could be used effectively and the total budget would be less than half the cost of owning a personal vehicle.

An integrated transportation system would dramatically reduce fuel use, emissions, and resource use. One railway passenger car worth $2 million lasts 20 years, and replaces the miles traveled by 6,000 automobiles worth $90 million. Far less urban and rural land would be consumed by the system and existing pavement could be removed in many areas. The technologies are fully available now, including self-propelled passenger cars, power plants using alternative fuels or solar photovoltaics, and distributed information systems for system management and customer travel efficiency.

When a country's leadership decides to follow an integrated transportation planning approach, several basic policies will support success. In urban and rural planning, the emphasis should be on developing around rail hubs (and light transit and subway stops) and place barriers to prevent sprawl development. Land-use plans should make movement by public transit quicker and easier than by highway. New roads should be built primarily to provide intermodal links. Policy makers should end subsidies for road-based transportation and develop and provide research funding needed for the integration of already proven component technologies. They also need to determine the appropriate balance between public and private ownership and management of the different elements of the system.

Singapore offers a useful model for other Asian countries; it has adopted an integrated and comprehensive approach, demonstrating the benefits of a long-term commitment to reducing the need for personal motorized transport. In September 2005, the People's Republic of China State Council Office issued nationwide "suggestions on giving the highest priority to urban public transportation development" that assigns top priority to developing urban public transportation as an important measure to increase energy efficiency in the transport sector and alleviate congestion. These guidelines directly promote the development of multimode intelligent public transportation systems, with priority treatment being given to public transport over private vehicles.

Source: Lowe, E. 2006-7. Interviews with Christopher Swan, CEO of SunTrain, a California transportation planning company. San Francisco.

Source: AFP.

use, projected energy costs, construction and maintenance of infrastructure, and manufacture of the vehicles themselves should be considered As suggested by the approach advocated in Box 6.6, master planning should integrate the skills and knowledge of urban planners with experts in environmental management, diversified energy systems, economic development, and community development.

Local governments also set parking policies, vehicle registration fees and quotas, and enforce age restrictions on vehicles. For example, Singapore has instituted mechanisms to control the movement of vehicles, thus reducing the need for personal motorized transport, along with energy use. These mechanisms include a high initial registration cost (about 150% of the vehicle's market value); an annual road tax that increases with engine capacity, along with a surcharge for older vehicles; and electronic, automatic road tolls. The city-state also has a vehicle quota system, which uses an open bidding process for certificates of entitlement to own a vehicle.[212]

Local Approaches to Improve Water Efficiency

While there is certainly a continued need for large-scale, capital-intensive projects where feasible and appropriate, some of the most promising responses to water scarcity are being mounted in households, farmers' fields, villages, and city neighborhoods across the developing world. Such locally-based approaches, whether small or large scale, have been found to be more efficient, more effective, more equitable, and more environmentally sustainable than top-down practices. Local management also elicits local commitment and promotes stronger local institutions, thus contributing to the sustainable management of entire watersheds.[213]

If local efforts are to expand, local authorities need to operate within a national framework that includes water codes, laws, and regulations, including sound water pricing. Because agriculture is a major consumer of water resources in most countries, much local effort should be focused on developing more sustainable agricultural water management systems. This, of course, links to land-use policy and planning due to the increasing competition between sectors for both resources (page 86). Local strategies also work best when complemented by national and international programs of resource management and conservation, as well as by scientific research and extension programs to develop and popularize ways to increase water efficiency.

Successful projects are determined by a mix of social, economic, and political factors, as well as by choices in technology and science-based analysis.[214] For instance, skilled management of subsurface water requires not only a detailed understanding of hydrogeology, geochemistry, and similar scientific disciplines, but also institutionalizing ways to prevent overpumping and competitive drilling, and promoting the sharing of the resource. It is also important to consider that investment costs should never outweigh the benefits obtained. For example, reducing leakage is only cost effective up to a certain point.[215]

As discussed in Chapter 4, it is important for national governments to promote planning of water resources at the scale of watersheds. Regional planning

212 Lowe, Ernest. 2006–7. Interviews with Christopher Swan, CEO of SunTrain, a California transportation planning company. San Francisco.

213 Brooks, David. 2002. *Water: Local-level Management.* Ottawa: International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

214 Ibid.

215 Global Water Partnership. 2004. *Current Status of National Efforts to Move Toward Sustainable Water Management Using an IWRM Approach*. Project funded by the Norwegian Ministry of Environment. April.

groups organized around watersheds offer a broader scope for integrated water resource planning. In the context of integrated water resources management, there are a number of methods for improving water efficiency on the local or regional levels.

For instance, farmers have long practiced conjunctive water use—the management of surface and groundwater together—but research in the past decade has delivered valuable new knowledge and techniques for improving this old approach. Improvements have been made in areas where canal systems are supported by good quality aquifers. In Uttar Pradesh, for instance, the irrigation agency turned a large unlined irrigation scheme into a massive groundwater recharge scheme. As a result, dangerously declining groundwater levels were reversed. Farmers now have enough water for two cropping seasons and yields and incomes have both increased.[216] Conjunctive water management can also involve controlling groundwater demand through pricing mechanisms, which some Asian cities have done to control overuse of groundwater by industry.

Other methods are used to improve conveyance efficiency—the proportion of the water delivered into the system that actually reaches end users. This often takes the form of reducing losses as a result of leaks and evaporation, include lining irrigation canals and fixing leaks in urban water supply systems through regular maintenance programs, thereby decreasing nonrevenue water.

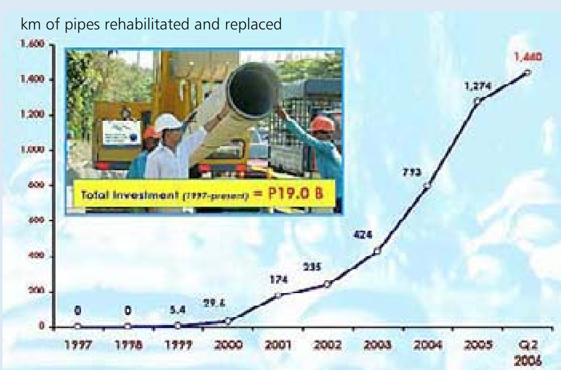
The effective management of nonrevenue water (NRW) is crucial to improving the efficiency of water use in urban areas. Less water losses meant more water supplied to more people. It is often said that there is no point in reducing NRW below about 20% of production, because the costs outweigh the benefits. Some cities in developed countries seem to disprove this idea. Singapore and some cities in Japan have reduced NRW to less than 10% of production.[217]

The case of Manila Water highlights how NRW can be drastically reduced through a concerted effort. When Manila Water took over the operations of the state-owned Metropolitan Waterworks and Sewerage System in Metro Manila's East Zone in 1997, the water network system was poorly managed and very inefficient. The network had deteriorated lines, illegal connections were widespread, and NRW was at a high 63%.[218] Part of their multipronged NRW reduction strategy involved a massive pipe replacement program. Since 1997, Manila Water has invested a total of P19 billion (about $450 million) to rehabilitate and replace over 1,440 kilometers of old and leaking pipes (Figure 6.1).[219] Manila Water also made crucial adjustments in its organization through an innovative NRW reduction program (Box 6.7).

Appropriate irrigation technologies and agronomic practices can also be used to improve application efficiency to ensure that a greater proportion of the water that is diverted from surface sources or pumped from the subsurface is actually used by the crop. In irrigation systems, this often involves giving the user more control over when and how much water is applied to fields, which often leads to huge gains in yield and saves water for other uses.

Some options are possible only through advances in technology, such as highly-responsive surface-irrigation systems, but often simple solutions based on local knowledge are more effective than large-scale and capital-intensive schemes. One practice that

Figure 6.2: Investment of Manila Water in Water Supply Infrastructure



B = billion, km = kilometer, P = Philippine peso, Q2 = second quarter.
Source: Manila Water Supply.

216 Ibid.

217 McIntosh. Arthur. 2003. *Asian Water Supplies, Reaching the Urban Poor: A Guide and Sourcebook on Urban Water Supplies in Asia for Governments, Utilities, Consultants, Development Agencies, and Nongovernment Organizations*. Manila: ADB and International Water Association.

218 http://www.adb.org/water/actions/phi/Manila-Water-Reducing-NRW.asp

219 Ibid.

Box 6.7: Manila Water's Nonrevenue Water Reduction Strategy

To address nonrevenue water (NRW) and other problems, Manila Water introduced the "Territory Management" concept, which divided the East Zone into 148 demand monitoring zones (DMZs) based on hydraulic boundaries. This approach led to the appointment of territory business managers (TBMs), whose task is to monitor the demand, supply, and variations between the inflow and outflow of water in each DMZ. To facilitate easier management, DMZs were further subdivided into District Metering Areas (DMAs), each handled by a district officer. To date, Manila Water has formed and commissioned 931 DMAs over the East Zone.

Empowered to make important decisions, TBMs and district officers have taken accountability and ownership of their respective DMZs and DMAs. Many underwent intensive trainings and workshops. From being field assistants, customer service support agents, and meter readers, they have now become experts in water supply management and NRW reduction, working closely with communities. Community leaders and representatives count on TBMs and district officers whenever they have water problems. Eventually, customers themselves were policing their own neighborhood, reporting illegal connections or tampered water meters to Manila Water.

In 2004, the concept of "Zero NRW DMAs" was introduced. A zero NRW DMA means that the DMA registers very minimal water losses. Major pipe-laying and pipe-replacement activities were done in priority DMAs. Furthermore, isolation and control valves were installed to make the areas easier to manage and monitor. Manila Water currently has 507 zero NRW DMAs, and the company is doing its best so that its NRW level reaches that of the more efficient cities in Asia.[a]

In addition, Manila Water's flagship program for the urban poor, *Tubig Para Sa Barangay* (TPSB) or Water for the Community, has proven to be an effective way of diminishing the high rates of illegal connections in depressed communities and informal settlements. As of June this year, Manila Water has completed over 500 TPSB projects all over the East Zone, serving a total of 900,000 poor people, and further reducing NRW.

As a result of these strategies, Manila Water was able to reduce NRW from 63% in 1997 to 29.9% in 2006. Water recovered from previous leaks and system inefficiencies was translated to water delivered to more customers. The billed volume of water has gone up to 938 million liters per day—more than twice the 1997 figure.

Manila Water has expanded its customer base to 803,000 households from 325,000 in 1997. Of this number, 148,000 households are from the low-income sector. With an average annual budget target of P5 billion (about $120 million) for major capital programs and NRW reduction, Manila Water will continue to look for new and appropriate technology and approaches to strengthen its operations.

[a] www.adb.org/water/actions/phi/Manila-Water-Reducing-NRW.asp

Source: McIntosh. Arthur. 2003. *Asian Water Supplies, Reaching the Urban Poor: A Guide and Sourcebook on Urban Water Supplies in Asia for Governments, Utilities, Consultants, Development Agencies, and Nongovernment Organizations.* Manila: Asian Development Bank and International Water Association.

Box 6.8: Drip Irrigation in Nepal

Source: ADB.

Low-cost drip irrigation in Nepal has been in place since 1995. Developed and tested by the International Development Enterprises (IDE), an international nongovernment organization, the system was promoted to small and marginal farmers in the hill districts of Nepal where irrigation water is scarce and inadequate for traditional surface irrigation. Before the adoption of drip irrigation, farmers practiced mixed farming (i.e., cereal crops and livestock raising) for subsistence and the yield from food crops was barely enough for family consumption. With the adoption of drip irrigation, most farmers have switched to high-value cash crops and most now produce surplus vegetables and fruits for family consumption and sale in the local markets and beyond. In the past 10 years the system has spread to 32 hill districts.

Source: Alipalo, Melissa Howell. 2006. Drip Irrigation Kits are Providing Women and Disadvantaged Farmers in Nepal with New Livelihood Opportunities. *ADB Review*. April-May. Available: http://www.adb.org/Documents/ Periodicals/ADB_Review/2006/vol38-1/big-change.asp

Box 6.9: Rainwater Harvesting

Despite numerous challenges in implementing large schemes, projects in the region have confirmed the great potential of rooftop water collection. For instance, in the Philippines and Thailand both government and household-based initiatives have played key roles in expanding the use of rainwater harvesting, especially in water-scarce areas such as Northeast Thailand. The initial per unit cost of rainwater storage tanks in Northeast Thailand is estimated to be about $1 per liter, and each tank can last for more than 10 years. The reported operation and maintenance costs are negligible.

The technical challenges of rooftop water harvesting involve collecting and storing water in a clean and cost-effective manner, problems experienced even where the practice is an established tradition. The capital cost of harvesting systems varies with the type of catchment, conveyance, and storage tank materials used. The feasibility of rainwater harvesting in a particular locality is highly dependent on the amount and intensity of rainfall. It has been found that water harvesting is most likely to be economical where rainfall averages 100–500 millimeters per year. With less or more rain, costs exceed benefits. It is also a function of the quantity and quality of water available from other sources, household size, per capita water requirements, and budget available.

The decision maker has to balance the total cost of the project against the available budget, including the economic benefit of conserving water supplied from other sources. The cost of physical and environmental degradation associated with the development of available alternative sources should also be calculated and added to the economic analysis.

To address the problem of the cost of storage tanks being beyond the means of most households in developing countries, two policy options are possible. A subsidy or alternative pricing scheme can be offered, or the system can be scaled-up to serve several families or a city block, thereby producing economies of scale and cutting unit costs. This second option requires some system of fair distribution and ongoing maintenance.

Sources: Global Development Research Center. *An Introduction to Rainwater Harvesting*. Available: http://www.gdrc.org/uem/water/rainwater/introduction.html. Akash Ganga. Available: http://www.raincentre.org/Brooks, David. 2002. *Water: Local-level Management.* International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

holds promise for the region is drip irrigation, a high-frequency low-volume water application procedure (Box 6.8). Available reports record increased water use efficiency estimated at around 90%, compared to 20–30% efficiency under surface (flood) irrigation.[220]

While improving the efficiency of irrigation systems gets more attention, making more efficient use of the estimated 16,000 cubic kilometers (km^3)of water used in rainfed agriculture (in comparison, some 2,500 km^3 of water are diverted annually for irrigation around the world.) can help reduce the need for new irrigation infrastructure in the first place. One method is field water harvesting, which involves diverting and gathering scarce rainwater for household gardens, watering stock, and even for drinking. It has been practiced for thousands of years in semi-arid areas and has tended to work best where there is not enough rain to support agriculture without intervention but enough rain to produce crops.

However, traditional methods of harvesting field water have fallen into disuse or failed to match new and growing demands. Research funded by the International Development Research Centre has demonstrated that combining old water-harvesting strategies with new methods can be made to work at scales measured in the hundreds of hectares. However, outcomes also indicate that smaller and less complicated approaches are more likely to be adopted and put to lasting use than grand designs of integrated resource management.[221]

Another method that can be implemented at the local level is rooftop water harvesting. Rainwater harvesting has been practiced for centuries and is most common in arid and semi-arid zones, although it is also practiced in monsoon climates and on islands where freshwater is never plentiful (Box 6.9).

220 Dr. Shrestha, Rajendra B. 2004, May. *Promoting Effective Water Management Policies and Practices: Gender Equality for Poverty Reduction through Improved Irrigation Management*. Manila: ADB. Available: http://www.adb.org/Water/PDA/nep/Final-Report-NEP-200302.pdf

221 Brooks, David. 2002. *Water: Local-level Management.* Ottawa: International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

Chapter 7. Investing in Resource-Efficient Infrastructure

Infrastructure investments often establish a country's pattern of energy use for subsequent decades. If traditional low-efficiency infrastructure is introduced, the economies and the sustainability of resource use will suffer in the long term. Thus, private and public investors in developing countries should consider opportunities to bypass conventional or outmoded infrastructure solutions, that is, to "leapfrog" over them by shifting investments to more resource-efficient alternatives.

Investment Needs in the Region

Developing countries need to invest in all types of infrastructures, including energy, transport, and water, to improve living standards and to achieve MDGs. ADB estimates that $60 billion per year is needed to expand urban infrastructure services between 2006 and 2010 for water supply, sanitation, solid waste management, slum upgrading, urban roads, and mass transit systems.

The *Asia Water Watch 2015* study commissioned by ADB, WHO, UNDP, and United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) estimates that annual investments of $8 billion will be needed over the next decade to meet MDG targets for safe drinking water and sanitation alone. In addition, investments are needed in irrigation services, river basin management, flood management and mitigation, and wastewater management.[222]

[222] ADB, UNDP, UNESCAP, and WHO. 2006. *Asia Water Watch 2015*. Manila. Available: www.adb.org/Documents/Books/Asia-Water-Watch/default.asp

While funding agencies can continue to play a key role in delivering and leveraging investments (Box 7.1), the infrastructure needs in the region will not be met unless the public and private sectors make massive and unprecedented investments. There is a clear need for expanded use of innovative financing measures—involving public-private partnerships—to respond to the heavy financing requirements of provincial and municipal governments for their infrastructure needs.

The nature of this infrastructure will determine the sustainability of resource use in the region for decades to come. It is not necessary to follow long-established centralized designs from the developed world that may have serious flaws even there. Instead, a considerable amount of investment can be shifted to more resource-efficient alternatives while providing the same level of service. There is a need for rigorous analysis of projected demand and cutting-edge technologies (such as those described in Chapter 8) that provide higher, long-term efficiency and that can be upgraded as new technologies become feasible.

Leapfrogging Conventional Solutions

There is great potential for leapfrogging over older-generation technologies to more advanced solutions with greater long-term resource efficiency, savings in costs, and environmental benefits. Society and the environment are beneficiaries of this investment, especially when older and more resource-intensive and polluting infrastructure is closed in the process.

Such systems may offer a means of skipping a stage of conventional infrastructure development. System designs can integrate advanced technologies and practices to optimize resource use and reduce the volume of waste through environmentally

Box 7.1: ADB: Delivering and Leveraging Investment in Water, Solid Waste, and Clean Energy

As a financer, the Asian Development Bank (ADB) can help deliver and leverage much needed investment in infrastructure services in the water, solid waste, and clean energy sectors. In each of these sectors, ADB assistance is helping support commercialization and private sector participation. In recent projects, there has been increasing reliance on market mechanisms for the delivery of infrastructure and services, particularly in large cities. Successful private sector participation in water supply and solid waste management in some developing member country cities indicates the potential for wide-scale development of public-private partnerships in these and other urban services.

Water sector. In response to the significant challenges in the region, ADB formulated the Water Financing Program (WFP), which seeks to make water a core investment area for ADB. Under the WFP, ADB proposes to increase its water investments to well over $2 billion annually. Launched at the 4th World Water Forum in March 2006, WFP builds on ADB work in the first 5 years of implementing the "Water for All" policy. It includes a large number of programmed water investments, a wide array of knowledge and awareness products, and regional cooperation services. The new program focuses on the delivery of substantial investment, reform, and capacity development in three key areas: rural water services, urban water services, and river basin water management. Concrete outcomes of the program will be safe drinking water and improved sanitation for about 200 million people, improved irrigation and drainage services affecting livelihoods of 40 million people, reduced flood risk for about 100 million inhabitants in rural and urban areas, and integrated water resources management introduced in 25 river basins.

The move recognizes the clear link between clean water and reducing poverty and is intended to make a significant contribution to the achievement of the Millennium Development Goals (MDGs).

Solid waste. ADB has financed projects across Asia and the Pacific to improve urban waste management—primarily the collection and disposal of municipal and industrial solid wastes. Over the past decade, approximately $900 million have been spent on projects with such components. Often these investments have been part of integrated urban development programs covering entire municipalities or sections of major cities and, in many cases, they also have involved public-private partnerships. There are also increasing efforts underway to reduce waste through refuse recovery or recycling, including the following projects:

- The Metro Manila Solid Waste Management in the Philippines project contributed to a more realistic view of the role of recycling in a solid waste management strategy for the city and provided individual local governments with assistance on recycling initiatives and related infrastructure development.
- Part of the loan funds for the Waste Management in Cook Islands project were used to construct a recycling center. A national waste strategy was also developed.
- The Efficient Utilization of Agricultural Wastes Project in the People's Republic of China is raising income through the generation of cheap energy and improved soil fertility. It has proven so successful that it is now being scaled-up across many provinces.

Clean energy. Out of the 99 environmentally classified loans approved by ADB from 1995 to 2005, 10 were energy projects worth $1.01 billion or 15% of the total cumulative lending of $6.8 billion. ADB has also supported a variety of policy and technical measures to promote energy efficiency and clean energy, having contributed over $30 million for 36 technical assistance activities over the past 10 years. Some recent projects are:

- Under a multitranche assistance for the development of renewable energy in Pakistan, several run-of-river hydroelectric power plants will be installed to expand power supplies in rural areas.
- Indonesia's hydropower and geothermal resources are being harnessed through a renewable energy development sector investment program.
- A financing facility is helping India's Tata Power Company Limited, a private sector company, implement two wind power projects with a total capacity of 100 megawatts.

ADB also seeks to significantly increase its investments in the clean energy sector in Asia through specialized private equity funds. Equity investments in clean energy funds, such as the FE Clean Energy Asian Sub-fund, are helping catalyze capital flows into energy efficiency, renewable energy, and other clean energy projects, especially in small- and medium-sized enterprises.

Source: ADB.

sensitive design and process optimization. However, after all value from the flow of residuals is captured, sound downstream disposal facilities will still be required.

These systems can sometimes require higher up-front costs, but costs usually be recouped over time through efficiency gains. Due to the small-scale and decentralized nature of such solutions, they may require developing innovative project designs that can be replicated in many parts of the region, in contrast to the usual way of funding few large projects. For instance, to operate effectively in the long term, large-scale wastewater reuse operations will require governments to develop the means of allocating costs and revenues, encourage or oblige those accustomed to disposing of wastewater for free to use the new system, and reform building codes and land-use regulations to permit and encourage wastewater recycling. When all these measure are taken, such operations can contribute to overcoming local water scarcities on a larger scale.[223]

For all these efforts, institutional capacity and arrangements are of paramount importance, in large part so that the costs and benefits of projects can be apportioned in a fair, equitable, and transparent manner. This is true on many levels. On the village level, it might include apportioning seasonal runoff for maximum usage and minimum losses of water and soil. On the national level, it includes institutionalizing rule-making and adjudication and ensuring that large projects do not accentuate inequalities.[224]

Through their agencies and extension services, governments can speed dissemination and promote education. They can also bring much-needed capacity in analysis, financial management, and infrastructure support and can also play a lead role in coordination and reconciliation. NGOs can play an important role in design, knowledge dissemination, and construction, and researchers can act as catalysts by introducing new research to decision makers or directly to families or farmers.

Three examples are provided below: decentralized wastewater systems, resource recovery and recycling systems, and green buildings. These options are compared with conventional solutions to give an idea of the benefits of leapfrogging to more sustainable solutions.

Centralized versus Decentralized Wastewater Systems

Centralized sewage treatment systems and their network of sewers are still the preferred choice of most civil engineers. In developed countries, such systems have been extremely successful in many cities. Singapore, lacking land area for more reservoirs, constructed separate drainage and sewerage systems to safely drain water into existing local reservoirs. The Public Utilities Board, the country's water authority, was able to collect all used water (in a country which is 100% sewered).

However, for many developing countries, there are a number of disadvantages in investing in costly, centralized systems. The major challenge for wastewater reuse schemes is that large-scale systems will probably not pay for themselves out of revenues. Capital-intensive systems take up considerable urban land and import technologies that are typically inappropriate. Thus, while selling treated water can cover operational costs, the capital costs are typically too high and/or maintenance proves too difficult. For example, a heavily engineered wetland was installed for Battambang, Cambodia to recycle all the wastewater of this small city. This system, funded by the International Development Research Centre, was found to be too maintenance-intensive and eventually stopped functioning.[225]

Other common problems of centralized systems are:

- The uncertain projections of future demand create a disincentive for increasing efficiency of water use and lowering the volume of effluents. The investment results in major consumption of materials and energy for construction.
- The benefit of investment is derived only in the long term, after an extended period of design, construction, and commissioning. Maintenance of the plant and sewer system adds to the operating costs, offsetting returns.
- The six different types of wastewater—high

223 Ibid.

224 Brooks, David. 2002. *Water: Local-level Management.* Ottawa: International Development Research Centre. Available: http://www.idrc.ca/water/ev-9440-201-1-DO_TOPIC.html

225 Ibid.

organic excrement, yellow water (urine), potable water for transportation of biomass, domestic wash water, industrial process and cleaning water, and storm water—are typically combined and a large volume of potable water is needed to move sewage through the collection and processing system.

- The combining of streams mixes toxic and nontoxic inputs and prevents reuse of the latter, such as storm water.
- If the treatment plant yields reusable secondary water, investment is required to build separate lines for its distribution.
- Sludge from treatment plants contains pollutants, which make use as by-products unsafe; the sludge consumes landfill space or pollutes river or marine ecosystems, and wastes an important material and energy resource.[226]

Decentralized wastewater systems can reduce public investment, increase efficiency of water use, generate renewable energy and organic fertilizer, and avoid solid waste disposal of sludge. Thus, they can resolve water, energy, and materials resource issues simultaneously. Some specific benefits are:

- Total investment is incremental and much smaller since it avoids the cost of long sewer lines, which are typically 80–90% of the construction cost.
- Small, decentralized treatment plants start operation within weeks to months, yielding direct and immediate benefits in wastewater treated and in revenues.
- The six different wastewater streams can be treated separately, enabling safer handling of toxic and septic flows, and easier processing and reuse of nontoxic streams. Secondary water is reused close to the source.
- Anaerobic digesters handle the separate flow of excrement, possibly blending it with garbage or farm biomass for production of methane.

Such systems have been in operation in some European cities for over 20 years, demonstrating their ability to deal with issues of hygiene and public health. Water managers have installed full-scale applications in India, Indonesia, Thailand, and other Asian countries.[227] Typical uses for secondary water include: industrial, construction, landscape and agricultural irrigation, scenic water, toilet flushing, road cleaning, car washing, and fire fighting

As discussed in Box 7.2, Beijing regulations require public and private buildings over a certain size to install their own sewage treatment plant. Three hundred systems are in place and another 100 planned. The city also built a secondary water system to make the output available for municipal and industrial uses.

Landfills and Incineration versus Resource Recovery and Recycling

Because of the rapid increase in the volume of waste, the cost of disposing of it through landfilling or incineration is growing. Yet, many cities that are finally starting to address their waste management problems are turning primarily to conventional solid waste management solutions, such as sanitary landfills or incineration that focus on improving downstream disposal, while failing to fully pursue upstream options to reduce the waste load.

This is clearly a mistake, as overreliance on conventional solutions is unsustainable. Waste disposal is expensive, both financially and in lost resources. It requires substantial inputs of labor (e.g., collection and processing); materials (e.g., construction of wastewater, landfill, or incineration facilities); energy (e.g., collection, water treatment, and incineration); and/or land (e.g., incineration or water treatment facility or landfill). Local governments in Asia spend a lot of money on waste collection and disposal (in some cities, solid waste management accounts for the largest proportion of

226 Based on Jules B. van Lier and Gatze Lettinga. 1999. Appropriate Technologies for Effective Management of Industrial and Domestic Waste Waters: The Decentralised Approach. *Water Science Technology.* 40-7: 171-183 and Christ, Oliver. 2002. Decentralized wastewater treatment systems. International Wastewater Symposium by Huber. 1 October. Available: http://data.huber.de/ueberuns/symposium/Symposium_Dr_Christ_DeSaR_e.pdf

227 van Lier, Jules B., and Gatze Lettinga. 1999. Appropriate Technologies for Effective Management of Industrial and Domestic Waste Waters: The Decentralised Approach. *Water Science Technology.* 40–7: 171–183l and Wilderer, Peter A. 2002. Decentralized Sanitation and Reuse: a new concept for economic water management worldwide. International Wastewater Symposium by Huber 1 October. Available: http://www.huber.de/hp570/International-Wastewater-Symposium-by-Huber.htm

Box 7.2: Beijing Decentralized Water Treatment System

In 1987, the Beijing Municipal Government issued the Management Regulation on the Construction of Wastewater Reclamation Facilities in Beijing (trial). According to this regulation, hotels with construction areas exceeding 20,000 square meters (m^2) and all other public buildings with construction areas exceeding 30,000 m^2 should construct their own wastewater reclamation facilities. Also, new residential areas were encouraged to implement wastewater reuse. This last category was detailed in 2001 through a regulation that required residential communities exceeding 50,000 m^2 to build a reclamation facility.

By 2002, more than 154 distributed wastewater reclamation systems (DWRSs) had been built in the Beijing central region, of which approximately 120 were in operation. The Water Saving Office of the Beijing Water Authority estimates that in 2006 approximately 300 DWRSs are in operation and another 100 are under construction, spread over the city on various scales and with different technologies.

According to their estimations, these systems are producing 50,000–60,000 cubic meters (m^3) of second quality water per day or 18–22 million m^3 per year. In 2005, the gross amount of recycled water used by agriculture, industry, community, and administration was estimated at 200 million m^3 per year which indicates that the share of the reused wastewater from the on-site facilities is approximately 10% of the total.

Pay-back times on the investments for the systems are typically 8–14 years for public owners and 4–6 years for private sector owners. This difference is because conventional water costs are about twice as great for the private sector as for the public sector.

Source: Mels, Adriaan, et al. 2006. Decentralised Wastewater Reclamation Systems in Beijing—Adoption and Performance under Field Condition. Paper presented at First *SWITCH Scientific Meeting.* University of Birmingham, 9–10 January.

the revenue budget), and typically devote more labor and transport to solid waste management than to any other municipal service. Siting these facilities is also difficult because of high land costs and "not in my back yard" attitudes in society. Cities that can afford advanced technology, such Singapore and Hong Kong, China, have chosen incineration because they cannot afford the land for landfills.

Also, while modern landfills now have advanced systems that can treat leachate and state-of-the-art incinerators satisfy stringent environmental parameters, these technologies are not infallible. For instance, leachate changes in terms of strength, biodegradability, and toxicity as wastes in a landfill ages over time. Bearing in mind that landfilled wastes may take up to 100 years to stabilize, finding fail-safe solutions can be a challenge.

Landfills are also a major source of methane. Along with heavy compaction and great depths, liners foster the very oxygen-starved conditions in which methanogenic microbes thrive, releasing methane as a by-product of decomposition of the organic material. Even in modern landfills with sophisticated methane capture systems, a large portion of the gas that is created over the lifetime of the landfill eventually escapes uncontrolled into the atmosphere, contributing to global warming

Source: AFP.

Box 7.3: Landfilling and Greenhouse Gas Emissions

Decomposition of organic waste (such as paper, food scraps, yard trimmings) under anaerobic conditions leads to the formation of biogas consisting of approximately 50–60% methane, 40–45% carbon dioxide, and trace amounts of other gases. Methane is a potent greenhouse gas (GHG), and among the anthropogenic emissions it is the second largest contributor to global warming after carbon dioxide. Methane produced at solid waste disposal sites (SWDS) contributes approximately 3–4% of global anthropogenic (GHG) emissions.

Methane generation in SWDS depends on several factors: (i) the total amount of solid waste, which is determined by population size and affluence; (ii) composition of the waste; and (iii) characteristics of the SWDS (i.e., climate, size/depth, degree of acidity, moisture). Growing populations, increases in incomes, and expanding industrialization can lead to increases in the amount of solid waste generated and, thus, escalating methane emissions from SWDS.

Climate change concerns and the disadvantages of traditional waste management methods have already influenced waste policies in some developed countries. In the European Union (EU), it was decided that the earlier strategy favoring landfilling was no longer acceptable and the amount of organic matter permitted to enter solid waste facilities was limited by the EU Landfill Directive (1999/31/EC). As a result of the directive and related national legislation, methane emissions from landfills in EU-15 decreased by almost 30% between 1990 and 2002. By 2010, GHG emissions from waste in the EU are projected to be more than 50% below 1990 levels.[1]

In 1993, the United States issued its Climate Change Action Plan (CCAP), which calls for cost-effective domestic actions and voluntary cooperation with states, local governments, industry, and citizens to reduce GHG emissions. To achieve the goals outlined in CCAP, the Environmental Protection Agency initiated several voluntary programs, including the Landfill Methane Outreach Program, which aims to reduce landfill methane emissions by encouraging projects that use landfill gas to produce energy.

There are two basic approaches to mitigation of GHG from SWDS: (i) reduction of organic waste (through recycling, composting, etc.), and (ii) collection of generated landfill gas. In developing countries, composting can provide an affordable, sustainable alternative to controlled landfilling. Composting decomposes organic waste aerobically into carbon dioxide, water, and humid fraction so that methane emissions can be avoided. An Israeli study analyzed the costs associated with GHG mitigation options for the waste sector and showed that the most cost-effective means to treat the degradable organic components of waste was by aerobic composting (investment of less than $10 to reduce emissions of 1 ton of carbon dioxide equivalent per year). The high organic content in municipal solid waste in developing countries and the relative simplicity of composting make this option highly applicable.

Sources: Eggleston H.S., L. Buendia, K. Miwa, T. Ngara, and K. Tanabe, (eds). 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Kanagawa, Japan: Institute for Global Environmental Strategies; Deuber, O., M. Cames, S. Poetzsch, and J. Repenning. 2005. *Analysis of Greenhouse Gas Emissions of European Countries with Regard to the Impact of Policies and Measures*. Report by Öko-Institut to the German Umweltbundesamt. Berlin. 253 p. European Environment Agency (EEA). 2004. Greenhouse gas emission trends and projections in Europe 2004. *Progress EU and Its Member States Toward Achieving Their Kyoto Targets*. EEA Report no5/2004. Luxembourg, ISSN 1725-9177. 40 p; Ayalon, O., Y. Avnimelech, and M. Shechter. 2000. Alternative MSW Treatment Options to Reduce Global Greenhouse Gases Emissions - the Israeli Example. *Waste Manage Res*. 18 (6): 538—544.

(Box 7.3).[228] In contrast, a viable alternative to managing organic waste—segregation and composting—does not create substantial greenhouse gases if done properly.

Given all the problems associated with overreliance on conventional solutions, it is essential that countries start viewing their waste streams as resources and as business opportunities, rather than as a dead loss. Waste disposal must be viewed as just one part, although an important one, of implementing integrated solid waste management. To be truly cost-efficient and sustainable, equal attention should be paid to upstream options to reduce waste for final disposal and to reuse and recycle valuable resources.

To this end, governments should be responsible for promoting appropriate and cost-effective technologies to manage partly recyclable products and unrecoverable wastes properly. Institutional infrastructure, including systems for collection, transportation, treatment, storage, recovery, and disposal, need to be established. Governments

228 Anderson, Peter. 2007. Landfills: A Failed Technology. Presentation at General Assembly of the EcoWaste Coalition. Quezon City, Philippines. 25 January.

should also take measures to improve the working conditions and minimization of work-related toxic exposure at collection, dismantling, recovery, and disposal facilities.

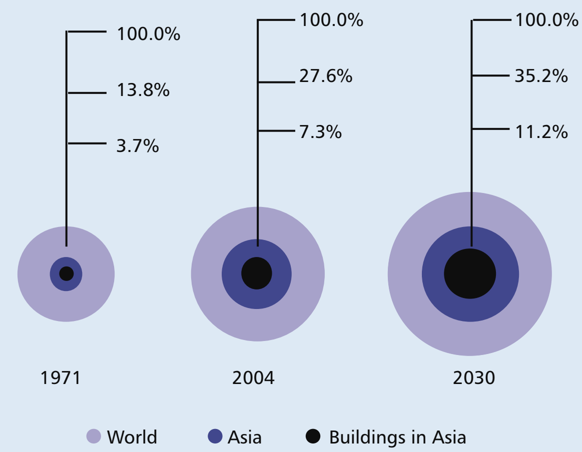
Analyzing the relative economic costs of waste disposal versus reducing, reusing, and recycling reveals that many options for more efficient resource management are cost effective and that there are many viable investment opportunities in resource efficiency. Upstream action is almost always more cost effective than disposal.

Conventional versus Green Buildings

The energy performance of buildings will become increasingly important to the energy outlook of Asian countries, as the built environment continues to boom throughout Asia. The PRC is constructing almost half of the world's new buildings and the built-up area in India more than doubled from 2000 to 2005. As a result, buildings in Asia are consuming more energy and producing more GHG emissions. As shown by Figure 7.1, buildings already account for 25–30% of Asia's total energy consumption as opposed to an estimated 7.3% of the world's energy consumption.[229] Asian building energy consumption could reach 35% of the region's total energy consumption by 2030.

Initial design of a building or retrofitting an existing one can greatly reduce the energy, water, and other resources needed for the life of the facility. Progressive corporations are choosing to build sustainable office buildings and other facilities because "green design" is proving to be less expensive in the long term. For instance, Ford Company rebuilt its largest factory by installing skylights and a "living roof" of sod that reduces toxins, boosts productivity, and saves money. Genzyme Corporation's new headquarters in Cambridge, Massachusetts, has a sod roof, skylights, blinds, and uses waste steam for heating. New York City's football stadium was designed to use solar cells and wind turbines to reduce energy and it sells excess energy to the electric grid. In Malaysia, a new skyscraper uses louvered windows and sky gardens to cool air.[230]

Figure 7.1: Energy Consumption of Buildings in Asia



Source: Hong, Wen. 2007. Trends in Asia's Building Energy Efficiency Policies. Presentation at International Conference on Climate Change. Hong Kong, China, 29–31 May. Available: http://www.hkie.org.hk/iccc2007/docs/PPT/5A%20-%20Energy%20Efficiency%20Policies.ppt

High-performance design creates the possibility that the building's management or owner can gain revenues from selling energy and recycled resources internally or externally. The cost savings alone would pay back any added cost of the resource-efficient design in relatively few years. Further savings can be gained through energy conservation practices in the operation of the building. Most of the possible high-performance innovations have been demonstrated to be cost effective in the operation of hotels, apartments, and office buildings, as well as individual residences.

In practicing high-performance design, architects and engineers draw on a variety of design choices to lower the energy and water demand of large buildings. The major physical systems are:

- highly resource-efficient design of the building envelope and equipment, such as elevators and heating and cooling systems;
- closed-loop system for generating bioenergy and recycling the water and biomass output of the building for its landscaping;

229 Hong, Wen. 2007. Trends in Asia's Building Energy Efficiency Policies. Presentation at International Conference on Climate Change. Hong Kong, China. 29–31 May. Available: http://www.hkie.org.hk/iccc2007/docs/PPT/5A%20-%20Energy%20Efficiency%20Policies.ppt

230 ADB. 2005. *Asian Environmental Outlook: Making Profits, Protecting Our Planet.* Manila.

- geothermal heat pump system to provide a share of heating and cooling through a commercially proven technology that taps the constant temperature of underlying soils or groundwater to provide radiant heating and cooling; and
- wind and solar energy units on the roof or building façade to complete the energy system.

Source: AFP.

High-performance buildings can use some or all of these design features together. For instance, designers of an apartment building or complex of buildings may install a closed-loop system for sewage and garbage, with anaerobic digesters processing the biomass. The resulting methane may be used as a direct input to the apartments or as a fuel for generating electricity. The clean, composted biomass output can be used as nutrient for rooftop gardens and landscaping. Other renewable energy sources can allow the building or complex to generate most of its own energy, or possibly a surplus. These renewable technologies include ground heat pump, solar water heating, wind generators, and photovoltaics integrated with roofing or façade surfaces. Concepts as simple as the orientation of the building in relation to the sun's path (optimal solar orientation) and passive solar design of the building envelope reduce total energy demand enough to significantly decrease commercial energy required in its operation over the years.

Life-cycle savings for operation of the building can be estimated and factored into the total financial analysis. For instance, highly efficient design of the building shell and windows and passive solar features reduce the energy requirements per square meter, enabling lower costs for equipment. Avoided public costs and GHG reductions are also accounted for in the financial analysis. Realizing these advantages also calls for innovation in real estate financing analysis.

A mainstream design and construction publication in the US in late 2006 noted that

> … the financial sector of the real estate industry, heretofore a casual bystander, suddenly woke up to green building—not necessarily because its members had miraculously developed an insatiable urge to save the planet, but because they had begun to see a viable new investment opportunity. In a market that has been flooded with cash, and amid a growing body of evidence that green buildings might in fact have some quantifiable advantages over 'conventional' buildings, developers, property investors, building owners, brokers, appraisers, lenders, banks, property insurers, real estate investment trusts, and pension funds started to open their eyes—and their pocketbooks—to the green building movement.[231]

[231] Building Design+Construction. 2006. *Green Buildings and the Bottom Line*. Available: http://www.bdcnetwork.com/article/ca6390371.html

Chapter 8. Promoting New Technologies and Solutions

Given that Asia is the world's fastest-growing environmental market, there will be significant and growing opportunities for Asian-based small and medium-sized enterprises to meet local demand. Governments can promote enterprise development through an industrial policy that supports the growth of a national environmental industry.

The global market for environmental goods and services is huge and growing fast. The UN Conference on Trade and Development estimated that this market was worth about $607 billion per year in 2005. Given worldwide trends toward greater attention to resource efficiency and environmental management, the market is projected to grow to over $800 billion over the next decade.

The Asia and Pacific market is estimated to account for roughly $40 billion (or just 6.5%) of the current global market. However, the market is expected to grow at an annual rate of between 10% and 12%—the fastest in the world.[232] The overall annual turnover in environmental goods and services in the developing countries of Asia could triple to more than $100 billion by 2015.[233]

This could underestimate the size of the regional market, because environmental requirements will likely be tighter and growth in the environmental goods and services industry will likely accelerate. Furthermore, many types of environmental infrastructure investment are not included in these figures. Annual demand for infrastructure investments in East Asia alone already amount to approximately $200 billion.[234] Whatever the size of the market, expanding opportunities are increasingly attracting mainstream venture capital funds, financing technologies ranging from solar cells and lithium-ion batteries to software that boosts manufacturing efficiency.

This chapter discusses the role of governments in promoting enterprise development and developing new technologies, and looks at some major areas of environmental technology and services that investors should consider as solutions to resource efficiency and economic development.

Government's Role in Enterprise Promotion and Technology Development

A big part of government's role in promoting resource efficiency is to support the development and/or transfer of promising technologies. Governments set policies for manufacturing and service firms and for the operation of its own facilities and services. They are themselves major investors in environmental technology and research and development (R&D), and play a role in regulating and guiding private investors, such as banks and investment funds. They also have the power to reduce subsidies that discourage development and use of various technologies. The private sector is more likely to invest in new technologies, such as renewable energy systems, if public policy provides a favorable government regulatory framework that permits full cost recovery. The costs and risks must be shared by society or the lowest-cost alternatives will continue to dominate the market, especially given the greater uncertainties associated with the introduction of new technologies.

All these functions give government special leverage in promoting resource-efficient investments.

232 Environmental Business International Inc. and ADB staff estimates.

233 Ibid.

234 ADB, Japan Bank for International Cooperation, and World Bank. 2005. *Connecting East Asia: A New Framework for Infrastructure*. Manila.

Some strategies that governments can pursue include

- identifying opportunities for international joint ventures, technical transfer, and transfer of business models;
- creating business incubators to provide space, assistance in financing, and administrative support for startups—these are often funded through public-private partnerships;
- developing government procurement policies that support new enterprise development in environmental technology;
- coordinating research by government, university, and private research institutes to advance the technologies required;
- offering incentives and promotional programs for private investment institutions, encouraging them to make loans for new enterprise development and expansion of existing firms; and
- creating revolving loan funds (as public-private partnerships) to support the same types of loans, particularly for SMEs.

Here, we focus on three important roles of governments in promoting technology development: research and development, technology transfer, and technology evaluation.

Research and Development

For national governments, the importance of promoting R&D is central to supporting investment in the environment and energy industries for resource efficiency. Most new technologies originate in the more developed countries, although some adaptations of these technologies or indigenous technologies are also produced in developing countries. R&D may be carried out by educational and research institutions, by industry institutes, and by the companies themselves. Government can encourage R&D by providing grants through nonprofit institutions and by offering tax credits or similar incentives to firms for R&D expenditure, so long as results will be publicly available. Developing green industrial parks can also help centralize research and extension services by providing a home for new and expanding businesses, along with business associations, incubator services, and a research base to improve the success of investment in various sectors.

R&D of EE technology is not as common in most Asian countries as in Europe and North America due to lack of funding. Efforts in Asia center more on technology transfer or technology procurement instead of local R&D. In cases where local R&D does exist, the focus is usually on small-scale projects and equipment. However, investments in EE R&D can provide huge energy and cost savings for countries. Locally developed and produced EE technology may be cheaper to produce and sell in the long run than importing similar technology.[235] An example is given in Box 8.1.

Box 8.1: Innovative Irrigation in India's Deccan Plateau

One area where research has played a key role in the region is improving the productivity of water in agriculture. For instance, on India's Deccan Plateau, researchers relied on local expertise to help the tribal people of the Akole Taluka region improve their crop yields and replenish groundwater supplies by implementing simple strategies. Gullies were plugged and water was diverted, which slowed runoff, reduced erosion, and allowed water to pool and seep into the soil. Later, rooftop harvesting and storage tanks were built, filled first by rains each year and later, in the dry season, by bullock-cart deliveries. With higher food production and rising incomes, villagers are embracing the new strategies.

Source: Conway, Kevin. Local Solutions to the Global Water Crisis. Available: http://www.idrc.ca/en/ev-25649-201-1-DO_TOPIC.html

Technology Transfer

Another strategy is to promote technology transfer by supporting partnership development with companies in more developed countries. Companies based in the EU, Japan, and US are rapidly entering the growing Asian market for environmental goods and services, competing with local firms. However, they often benefit from joint ventures with these same firms and are themselves employers of the local workforce. In many cases, a foreign company with an advanced

[235] UNEP. 2006. *Improving Energy Efficiency in Industry in Asia: A Policy Review.* Bangkok, Thailand.

technology may be relatively small and needs to partner with local entrepreneurs and technologists to market their innovations. Even larger firms usually find market entry in Asia and the Pacific easier with such a partner.

For instance, a US company builds, owns, and operates sludge treatment facilities, financing installations with outside money. The company supplying the sludge pays a tipping fee and has the choice of being a co-investor to receive revenues or energy from the facility. Many energy service companies favor a similar participation in the benefits of their intervention, and also open markets for new technology companies (energy service companies, page 82).

In addition, Asian entrepreneurs can benefit from collaboration within and among the different clusters of this industry. Often different types of renewable energy complement one another when integrated in a whole building design or an energy generation facility. For instance, fuel cells may become a highly efficient way to store power from intermittent sources like solar and wind. Policy makers can benefit from discussions with environmental trade associations on the types of incentives and market support that firms need.

Evaluating Environmental Technologies and Services

There is a great deal of innovation in environmental technology, both products and services. Competent, systems-based evaluation of environmental technology innovations is essential for understanding how they can most effectively be deployed, and possibly for opening up cost-effective use earlier in the development cycle. Public works managers, for instance, could use support in assessing the claims of competing salespersons offering solid waste management systems. At a higher level, they might benefit from examining broad strategies for cutting wastes to create a context for choosing among technologies.

Another important role for technology evaluation is assessing technologies for commercial application. A technology that appears effective at a bench test or as a prototype may fail when applied commercially. The failure may be strictly technical or come from errors in estimating the real costs of construction or operation. A commercially proven technology is typically preferable to one that is at an earlier stage. However, many municipalities and companies see high value in installing renewable energy systems or technologies for reducing GHGs even when such systems are not yet cost competitive. They want to build capacity in this area so they will be ready for more complete application later.

In addition, it is important to consider the support and maintenance needs of technologies. Often environmental technology investments fail because the system requires a level of support that is not available in the region where they are applied.

Some useful criteria for evaluation [236] are:

- Has the technology or service demonstrated success at a commercial scale?
- If it involves the use of a by-product, does it offer the highest and best use of that resource?
- What are the financial, environmental, and social impacts of using this technology (crop biomass energy, for instance, may use more energy—and cause more environmental impacts—than the energy it generates)?
- Does the technology require high levels of energy and water to function?
- What level of support and maintenance does the technology require? Can investors be sure that this support will be available at the sites where the technology will be used?
- Is there a financially feasible business model for the company or agency offering the solution and the one that will operate the technology?
- Do the technology's benefits justify initial public subsidy of the business? Perhaps it cuts public costs of disposal of solid waste or sludge or creates major employment opportunities.
- Does the innovation meet a narrow or broad need of sponsoring agencies, companies, or other end users?
- What are the opportunities for applying the technology as part of a more complete system?
- How does this technology or service compare with competing products in terms of these criteria?

[236] Lowe, Ernest. 2006. *Eco-Industrial Park Training Manual*. Prepared for Korean National Cleaner Production Center, Seoul.

Given all these possible criteria, it is important for technology evaluation teams to work with clear criteria to evaluate competing offerings. They must always watch for high-leverage solutions that offer benefits in several areas, such as a bioenergy system that processes both farm and village biomass (crop residues, manure, sewage, etc.), reduces contamination of water and land, and yields organic fertilizer along with biogas. An independent technology evaluation and strategic planning firm could fill a valuable role in this market. Parallel opportunities could be developed in supporting industrial plant managers and R&D teams.

Business Opportunities in Resource Efficiency

This section discusses some of the huge and emerging business opportunities that have arisen as part of the drive to use resources more efficiently. Investment by companies and government agencies to increase their resource efficiency opens domestic markets for new and expanding environmental enterprises. There are also growing export markets in this sector.

The business opportunities covered in this chapter are

- resource recovery firms, including collection, processing, reuse, remanufacturing;
- renewable energy and EE firms, including solar, wind, biomass gas and fuel, and geothermal;
- biomass production and processing (bioenergy and bioproducts);
- wastewater reuse for agricultural and urban uses;
- sustainable farming support companies; and
- green chemistry and nanotechnology companies and institutes.

Resource Recovery and Recycling

As discussed throughout this paper, by-products that were once regarded as wastes or low value by-products are increasingly looked at as valuable resources. As a result, initiatives to recover and treat used materials for reuse or recycling are increasing worldwide, and material markets arising from recovery are developing and expanding internationally. Similarly, "waste" water is increasing in value in the many water-scarce regions of Asia and there are markets for treated secondary water.

Integrated resource recovery systems manage by-products from industrial, residential, commercial, and government sources for optimal recovery of value. This creates major enterprise and employment development opportunities in collection, processing, reuse, remanufacturing, and bioenergy.

Source: Kojima Mickikazu, JETRO.

In most developing countries, biomass constitutes the largest portion of municipal waste streams and may be used as feedstock for the production of bioenergy or various products, such as nonchemical fertilizer (see discussion on biomass production and processing on page 130). However, other materials can be recovered and treated to be reused or recycled, including metals, plastics, paper, and waste electrical and electronic equipment (Table 8.1).

Waste recovery and recycling already form a profitable industry in the developed world. The Bureau of International Recycling estimates that the recycling industry employs about 1.5 million people and represents revenues of $160 billion worldwide.[237] A world waste survey estimated that the market revenue in Japan was $67 billion in 2000 and $47.3 billion in the US in 2003.[238] In highly industrialized

[237] Lacoste, Elisabeth, and Philippe Chalmin. 2006. *From Waste to Resource: An Abstract of "2006 World Waste Survey*." Cyclope. Commissioned by Veolia Environmental Services. Paris, France.

[238] Ibid.

Table 8.1: Typical "Wastes" and their Recycling Potential

Waste	Recycling Potential
Biomass	Several types of compost can be produced using biological processes and depending on the basic organic waste. In addition to regulatory incentives, the future of compost depends on its environmental and agronomic qualities and on the dynamism of its market.
Paper and cardboard	The exchange of recovered paper is increasing, notably in Asia and in particular in the People's Republic of China, whose imports are constantly increasing (17 million metric tons [Mt] in 2005). The recovery rate and the deposit level in Asian countries do not meet their demands. New investments are increasing the need for recovered and less expensive fibers.
Plastics	Increasingly stringent regulations and growing demand for recovered plastics, particularly in Asia, favor the development and internationalization of this market. However, due to many limiting factors (e.g., cost of collection systems, volatile prices), the recovered plastics market represents a low proportion of the 169 Mt of plastics produced globally in 2003.
Ferrous metals	Scrap metals are essential in the production of steel and have become true commodities. In 2004, world production of scrap metal rose to 450 Mt and consumption reached 405.5 Mt. Ferrous metals can be recovered from municipal waste (e.g., end-of-life vehicles, large electrical appliances, tin cans), construction waste, shipbreaking, and offcuts recovered from steel production.
Nonferrous metals	Most nonferrous metals reached record prices in 2005, which boosted supply and demand of secondary metal. The demand for aluminum, nickel, and copper is rapidly increasing in emerging countries.
Batteries	Prices reached by copper, lead, nickel, and cadmium over the last few years were high enough to cover the costs of collecting and recycling 15 billion batteries and accumulators thrown out each year around the world; 3.2 Mt of secondary lead is recovered worldwide.
E-waste	It is estimated that 10 million computers contain 135,000 metric tons of recoverable materials. Waste electrical and electronic equipment contains a significant quantity of recyclable materials, such as base metals (steel, aluminum, copper, lead, and zinc), silicon, glass, plastic, and precious metals (gold, palladium, platinum, and silver).
Asphalt and concrete	This material can be crushed and reused for a variety of purposes, such as base aggregate for street maintenance activities, backfill in sewer trenches, and road shoulder maintenance.
Ash and Slag	Brick makers and concrete mixing sites use fly ash as a low-cost ingredient that also can add strength to the product. Bottom ash is used in road construction and other construction requiring aggregates. Slag from blast furnaces can be used as an alternative material for cement production, and can reduce greenhouse gas emission from substituted limestone.
Sludge	Depending on the biological content, municipal sewage sludge and food processing sludge is a source for biogas energy using anaerobic digesters. Multi-stage digester processes can greatly reduce the bulk of toxic sludge, decreasing hazardous disposal costs and environmental pollution.

Source: Lacoste, Elisabeth, and Philippe Chalmin. 2006. *From Waste to Resource: An Abstract of "2006 World Waste Survey."* Paris: Cyclope. Commissioned by Veolia Environmental Services.

economies, major material industries and consumer goods makers are competing to expand their business in material recovery using their advantages of existing market networks, technologies, and know-how. This trend is supported by raising consciousness on EPR, as well as instruments such as product take-back and deposit funds.

In Japan, local governments are implementing policies geared toward the establishment of recycling-based systems with the support of the Ministry of Economics, Trade and Industry (METI). Kitakyushu City, the first city designated as a METI "eco-town enterprise," is implementing programs that will transform the Kitakyushu into a "full-scale recycling city" (Box 8.2).

Meanwhile, in developing Asia, a major formal industry is growing from its roots in the informal economy. In time, the recovery and recycling industry in developing Asia may surpass that of Japan and the US. ADB analysts estimate that the recycling market in Asia could reach $320 billion per year (assuming that recycling rates will double to 20% of the waste generated) and that future waste generation reaches European levels of about 1 ton per person per annum, at a conservative value of $80 per ton.

Box 8.2: Kitakyushu—An Asian EcoTown

The Kitakyushu Eco-Town Project is composed of the Comprehensive Environmental Industrial Complex, the Hibiki Recycling Area, and the Practical Research Area. The Comprehensive Environmental Industrial Complex enables companies to handle and distribute recyclables generated from a broad area. It features thermal and materials recycling. The Hibiki Recycling Area supports small and medium-sized enterprises that are venturing into the environmental industry by preparing business sites for long-term lease. The Practical Research Area acts as a center for environmental industries in the city by bringing together organizations that engage in research and development on cutting-edge environmental technologies in this area.

The city also implements a wide range of eco-efficiency measures toward making the city sustainable, including renewable energy development, treated sewage utilization, a biotope network, regional consumption of agricultural produce, biomass composting, greening of roof-tops and walls, a green village project, and a recycling port project. A new recycling program requires residents to separate recyclables at the source, using plastic bags of different colors for different types of waste. The program also includes recycling various items, such as old fluorescent lamps and milk and juice cartons.

Behind all of these movements is a full-scale effort to build collaborative activities with city stakeholders and interactive communications with citizens. There is a 10,000-strong citizens' forum for sustainable society, a children's eco-club, a regional currency project for eco-city development, an eco-partner project, community involvement for local cleaning activities, promotion of a community-based recycling system, and a green consumer project.

Source: Institute for Global Environmental Strategies. 2005. *Good Practices Inventory: Kitakyushu Eco-Town Project.* Available: http://www.iges.or.jp/APEIS/RISPO/inventory/db/pdf/0147.pdf

However, most countries in the region still have insufficient technologies in resource recovery and recycling (Table 8.2). As mentioned in Chapter 4, the 3R Knowledge Hub recently undertook research aimed at presenting the prevailing technology, management, and policy gaps preventing 3R implementation in 13 selected Asian countries. The study concluded that only Japan fulfilled almost all the technology aspects in the three areas studied—urban municipal solid waste, health care waste, and electronic waste (Box 8.3).

Fortunately, practices in developed countries like Japan, Republic of Korea, and Singapore can be considered as benchmarks. As discussed in the previous chapter, developing countries can fill technology gaps by leapfrogging to technologies that are found to be predominantly successful in developed countries, although this depends on their application, generation rates, and waste composition.

Much of the growth in this sector will likely occur in the PRC, where new legislation is supporting rapid growth of the industry, now valued at $5.4 billion per year. PRC authorities recently promoted the creation of the first national recycling business—China National Resources—to handle the potentially lucrative business of recycling electronics. By 2007, the company will invest up to $100 million to set up five large recycling industrial zones to serve the PRC's major manufacturing centers.[239] These zones will take waste materials from throughout their regions and will house recycling plants for every major commodity, including steel and aluminum, and will handle toxic chemicals like mercury and lead. Electronics manufacturers can subcontract them to make sure all of their used products are properly collected and recycled in accordance with the new laws. The company will also set up consulting companies to help electronics manufacturers comply with the new laws.

Over time, resource recovery and recycling will grow into a mature industry in developing Asia, featuring core resource-recovery businesses, manufacturing firms, and wholesale and retail businesses, as follows:[240]

Core resource-recovery businesses. These involve drop-off, buyback, and distributed collection strategies for discards, and may be operated by an integrated resource recovery program, by a resource recovery business association, or by collection companies. These companies include

[239] Wang, Peter. 2005, May. *Precious Waste: China National Resources Wants to Grow the Recycling Business into a Trillion-dollar Industry in the Country*. AsiaInc. Available: http://www.asia-inc.com/May05/Fea_precious_may.htm

[240] Lowe, Ernest A., and Andreas Koenig. 2006. *Eco-Industrial Park Training Manual.* Prepared for Korean National Cleaner Production Center, Seoul.

Table 8.2: Technology Status for Resource Recovery and Recycling of Three Types of Waste for Selected Asian Countries

Waste Category	Technology	Country									
		Bangladesh	Bhutan	Cambodia	PRC	India	Indonesia	Malaysia	Philippines	Thailand	Viet Nam
Urban Municipal Waste	Thermal Recovery		◊	◊			◊	l			◊
	Fuel Recovery		◊	◊			◊	l			◊
	Material Recovery		◊	n	n	®	n		n		n
	Sorting	n	®	n	n	®	n	◊	◊	◊	n
	Pulverizing		◊	n	®	®	◊	◊	◊	◊	n
	Composting	n	◊	◊			n	◊	◊	n	
	Incineration	®	◊	◊	l		®	l	®		®
	Collection	®	®	®		n	®		n		n
E-Waste	Material Recovery	®			n	®	◊	®	®	®	®
	Sorting	®	◊		®	®	®	®	®	®	®
	Pulverizing	®	◊		®	n	◊	◊	◊	®	◊
	Collection	®	®			®	◊	®	n		®
Health Care Waste	Thermal Recovery	®	◊	◊	n	n	◊	l		®	◊
	Fuel Recovery	®	◊	◊	®	n	◊	l		®	◊
	Material Recovery	®	◊	◊	n	n		◊		◊	◊
	Sorting	®	◊	®	®	n	◊	◊		◊	◊
	Pulverizing	®	◊	®	®	n	◊	◊		◊	◊
	Incineration	®	◊	®	N.I.	n	◊	N.I.			N.I.
	Collection	®	®	®		n	◊	®	®		

l = formal and strong; = formal and weak; n = informal and strong; ® = informal and weak; ◊ = technology gap; N.I. = no information, PRC = People's Republic of China.

Formal and informal denote the presence or absence of regulations, laws, and rules to govern an activity. An activity is said to be formal if it has specific laws and rules that mandate, enforce, encourage, and allow the activity within a specified regulatory framework. An informal activity is one that does not have any law, rule, or guiding policy; still, the activity might be happening by itself.

Strong and weak represent the level and scale of a particular activity. A strong activity typically uses state-of-the art technologies. A weak activity is one carried out at the micro and meso scale, often for livelihood purposes. Weak activities generally use primitive technologies and often operate haphazardly.

Technology gap denotes where no law or rule exists and the practice is totally absent.

Source: 3R Knowledge Hub Secretariat. 2007. Gap Analysis in Selected Asian Countries. Bangkok: Asian Institute of Technology.

- recycling firms that process paper, plastic, chemicals, glass, tires, biomaterials, textiles, and metals into usable feedstocks;
- niche collection companies that serve particular types of businesses by gathering and delivering unused materials to other firms, e.g., office discards, food and paper discarded by restaurants, solvents, and other chemicals;
- composting and soil mixing firms that target soils, ceramics, plant debris, putrescible items, and scrap wood (all organic and mineral materials with no higher-value use);

Box 8.3: Findings of the Survey on Gap Analysis in Selected Asian Countries

Municipal solid waste. 3R-oriented technologies, such as thermal recovery (direct combustion of waste to recover heat) and fuel recovery (production of refuse-derived fuel and packaging-derived fuel from waste), are effectively practiced in India, Japan, Republic of Korea, Malaysia, and Singapore. Such technologies as incineration are formally strong in the People's Republic of China (PRC), Republic of Korea, Malaysia, Philippines, and Thailand. Successful countries have good technologies and adequate management and policy instruments. In countries like Cambodia and Viet Nam, technologies for materials recovery, sorting, and pulverizing are informal but strongly practiced. Remarkable technology gaps were found in Bhutan, followed by Cambodia due to lack of national policies; barriers to international flow of information, technology, and services; and insufficient international cooperation.

E-waste. Japan was found to have formal and strong technologies like material recovery, sorting, and pulverization. Next are the Republic of Korea and Thailand, with successful practices in material recovery and sorting. Among the other countries, Cambodia has informal but strong practices, while Bangladesh and the PRC have largely informal and weak systems. This can be attributed to the insufficient management and policy frameworks.

Health care waste. Among the 3R-based technologies for health care waste, incineration is predominant in such countries as PRC, Japan, Republic of Korea, Malaysia, Philippines, Singapore, and Thailand. Waste-to-energy technologies for recovering heat energy, fuel, and materials were found to be practiced strongly in the Republic of Korea, Malaysia, and Singapore. In India, although various technologies are practiced, they are often informal, but strongly deployed. This is due to the inadequate policies and management systems. In countries like the Philippines, appropriate policies and essential instruments are in place but there is lack of cooperation and a dearth of good practices. Bhutan and Viet Nam are among the countries showing insufficient management systems and policies.

3R = reduce, reuse, recycle.

Source: 3R Knowledge Hub Secretariat. 2007. *Gap Analysis in Selected Asian Countries*. Bangkok: Asian Institute of Technology.

- construction and demolition businesses that collect and process debris from deconstruction or dismantling, used building materials (e.g., scrap lumber, doors, windows, plumbing fixtures, and ceramics), concrete and asphalt recycling, and processors of roofing materials, bricks, and mixed demolition debris;
- biomass energy firms that use selected organic materials to produce methane, ethanol, or methanol sludge from sewage treatment, pharmaceutical, food processing, and chemical plants are large-scale sources);
- biomaterials firms that process biomass to produce a variety of feedstocks, including some higher-value specialty chemicals;
- dismantlers that reduce such goods as older electronics and household equipment that cannot be repaired or reused, to usable components and, with good management, safe discards; and
- by-product specialists, who negotiate with industries to use discards not taken by other companies in a by-product exchange.

Manufacturing firms are a major component of the materials recovery sector. Examples include

- firms that use the feedstock created by the processors to manufacture recycled products;
- plants that remanufacture capital and consumer goods (electronics, construction, transportation, and medical equipment are major niches for remanufacturing);
- producers of equipment for resource recovery, renewable energy, and EE;
- repair shops for household and office equipment; and
- firms that draw on outputs of any of the above, such as: greenhouses and intensive agriculture with specialty food processing (energy, water, and carbon dioxide); fish farms (energy and water); microenterprises making products or crafts from recycled materials or offering repair services; environmental consulting and service companies; and investment recovery firms.

Wholesale and retail businesses involved in recovery include companies dealing with

- reused household and office equipment, clothing, furniture, etc.;
- used and remanufactured industrial equipment and materials;
- finished goods from firms with high use of recycled materials; and
- brokering of recycled commodities.

The increasing international trade in secondary materials will continue to be a major driver for expanding resource recovery and recycling operations in developing Asia, despite the potential that such trade may lead to increased pollution and health risks (page 165). Several major multinational corporations have initiated efforts to establish global recycling systems that involve the collection of used products from various countries and disassembling them at a single plant, followed by the reuse or recycling of components. For instance, AER Worldwide, a global electronics recycling resource and components distributor, recently opened an electronics de-manufacture and sorting center in Penang, Malaysia. The center will provide original equipment manufacturers and contract manufacturers located in Asia with close-to-source material sorting and deconstruction services.

Another good example is Fuji Xerox Co., Ltd, which developed a take-back system, drawing on their lease-based business model that has proven effective in both developed and developing countries. In late 2004, the company opened a recycling factory in Chonburi province, Thailand, the first case in Asia of a company crossing borders to set up a regional recycling center (Figure 8.1). The factory recycles end-of-life copy machines that are collected from the company's nine operation sites in Asia and the Pacific.

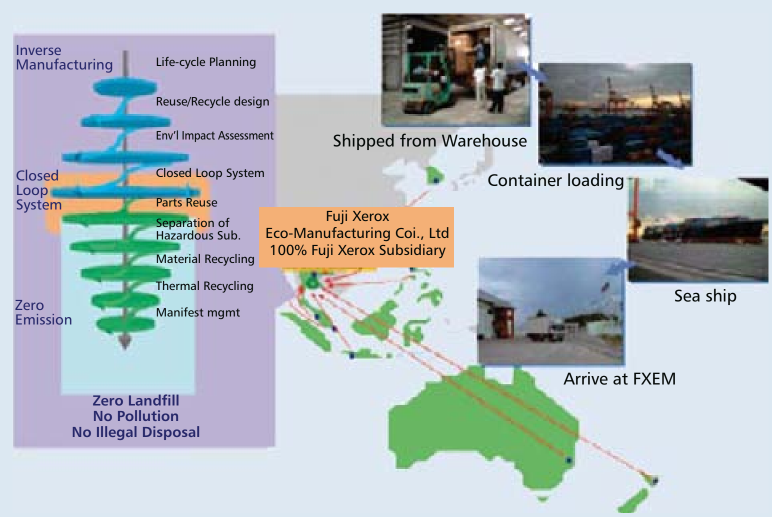
Initially, senior Thai government officials objected to the plan, questioning the necessity of bringing waste from other countries into Thailand. The Government of Thailand imposed two conditions: (i) no import of wastes or used products for final disposal in Thailand, and (ii) reexport of hazardous elements to countries with appropriate treatment facilities. In response, Fuji Xerox has proven itself to be a leading recycling company. It has achieved a 99.6% waste recycling ratio (in terms of weight) based on its system of separating the collected materials into 64 different categories that include iron, aluminum, lenses, glass, and copper.

Alternative Energy Business Development

As discussed earlier in this report, the accelerating rate of climate change, along with increasing fuel prices, is driving increased interest in EE measures, as well as increased commercialization of renewable energy technologies. The pace is expected to grow even more with the help of CDM, which will allow EE and renewable energy projects executed in developing countries to generate revenues through certified emissions reduction.

The primary categories for alternative energy business development include the following:[241]

Figure 8.1: Transnational Recycling Mechanism by Fuji Xerox



Source: Watanabe, Tomio. 2006. Fuji Xerox International Resource Recycling System in Asia-Pacific Region. Presentation at Asia 3R Conference. 30 October–1 November. Tokyo.

Energy service companies (ESCOs). As described earlier in this report, these companies conduct energy audits, design more efficient energy systems for new and existing buildings or processes, and play a key role in design of systems for cogeneration

[241] Lowe, Ernest A., and Andreas Koenig. 2006 *Eco-Industrial Park Training Manual*. Prepared for Korean National Cleaner Production Center, Scoul.

and cascading of energy from one quality of use to another. Such ESCOs often offer to design, build, and finance performance-guaranteed system improvements. Many also offer training in energy conservation behavior for both industry and commerce. Energy services could be part of a comprehensive resource service company (RSCO) that also works to optimize water and materials efficiency.

Manufacturers of EE equipment. EE equipment is increasingly being designed and produced in the region, including products for more efficient lighting, heating, ventilation, and air conditioning systems; appliances; insulation; windows; industrial and office equipment; and energy-use sensors. National policies and instruments with clear EE targets can play a key role in promoting this trend, as can ecolabeling schemes and RoHS legislation.

Manufacturers of equipment for renewable energy. Such products include wind energy generators and support equipment; solar cells; fuel cells for energy generation and transportation; solar water heaters; biomass energy systems, including landfill gas recovery, digesters, and combustion; sterling engines; and ocean energy from waves and thermal gradients.

Specialty engineering services. These offer resource assessment, feasibility studies, cost analysis, planning, design, project coordination, and installation/startup contracting services, as well as ESCO models of design, build, and finance performance-guaranteed renewable systems and system improvements. An example is engineering and construction of ground, heat-pump geothermal systems to cool buildings in the summer and warm them in the winter.

System integration. Integration could emerge in the next decade as a significant business opportunity. The feasibility of using renewable energy could be enhanced by integrating two or more of the technologies needed to best meet a specific site's needs. A company serving as energy systems integrator for industrial facilities or for commercial, office, and residential buildings could serve a variety of functions in engineering/design, installation, and maintenance. Such a company could assess the customer's energy requirements and budgets, determine EE strategies that can reduce the demand, select the optimum combination of renewable sources, and coordinate installation of the system. It could also negotiate financing and sales of excess energy to utilities. Depending on the tax structure and incentives provided, such a company could conceivably operate as a distributed utility, owning the equipment and selling the energy services.

Fossil fuel plants require large, long-term investment, with scale usually based on projections of present levels of EE. Wise investors would use scenario planning to view alternatives, including much higher efficiency of use, more rapid commercialization of renewable systems, and diversified energy portfolio investment.

One of these alternatives is distributed renewable energy systems that, with incentives for EE and conservation, can reduce or avoid large investments in fossil power plants and transmission grids. In regions without major power plants and distribution grids already built, a distributed, integrated system of renewable energy sources can be cost-competitive with fossil fuel-based systems and the costly power grid they require. For instance, new urban development in some regions of western PRC involves constructing basic infrastructure and offers the opportunity to use decentralized approaches.

Policy makers need to do a whole-system cost-benefit analysis, counting the benefit of using biomass rather than disposing of it, the high line loss of energy in electricity grids, and the cost of pollution from coal or oil fired plants. The benefits of such a distributed energy system would be enhanced by energy conservation policies as well as policies and building codes supporting high-performance design of new buildings and facilities.

Biomass Production and Processing[242]

In most Asian countries, the majority of the municipal waste stream is biomass, most of which is discarded in landfills or dumped in the countryside. Industries,

242 This section is based on materials from Indigo Development (www.indigodev.com) and policy options from an Eco-City planning process for the Dalian Development Zone in the PRC, conducted by RPP International and Indigo Development. Ivan Weber, President of Weber Sustainability Consulting made major contributions.

public utilities, and households waste valuable natural resources at a significant cost to the economy. Discarded organic resources (wastes) come from many different sources and occur in many forms and with many attributes. Potential supplies of biomass include both virgin materials from dedicated crops and a high variety of residues from harvesting, waste streams from processing, wholesale and retail consumers, and collection systems. Only a few types of discarded biomass are now recovered, e.g., landscaping discards to compost and food scraps for animal feed. Farmers may plow a portion of crop residues into soil or use them for compost, but many still burn them, adding to local air pollution and GHGs.

Most current recovery of biomass discards operates at a relatively low economic value. A potentially profitable goal for Asian economies is to establish a system for highest-value conversion of biomass to both energy and materials. Achieving this goal could enable business development, delivering services and technologies throughout Asia. However, many large and small schemes in the region have not worked or are not operating at full capacity. The resource-recovery industry, including biomass processors, is underdeveloped and fragmented in many Asian cities and regions.

There are a number of reasons for this, including high operating and maintenance costs compared to open landfills and incomplete separation of materials, such as plastics and glass, which results in poor quality compost for agricultural application. Environmentally preferred energy, products, and materials from biomass also face a market-entry challenge because they compete with traditional producers, while fluctuations in supplies cause unstable prices for recovered materials. New businesses in emerging fields tend to have a high failure rate.

In pursuing opportunities in production and processing of biomass, it is important to understand some of the potential problems that may result. Planners must consider that too-heavy focus on the commercial viability of technologies for biomass recovery may delay emergence of more productive and value-adding options. For example, some organic chemistry products and hydrogen for fuel cells could become commercially feasible sooner in integrated biomass processing systems. In addition, when the biomass processing industry is developed, it risks damaging environmental impacts to air, water, and land, as discussed in Chapter 3.

The following discussion of business opportunities in this sector covers opportunities to convert biomass to energy (bioenergy) and biomass to products (bioproducts), as well as the integration of production and processing of biomass resources.

Bioenergy

Conversion of biomass to energy involves various techniques and sources, such as crops for biofuels or waste sources from garbage, sewage sludge, landscape trimmings, and farm and food-processing residues. Bioenergy schemes have been developed as one way to address rising energy costs, energy independence, and GHG control. PRC, India, and other Asian countries are advancing with large and small projects. However, conflict with food production and impacts on sustainable land use and ecosystems need to be carefully assessed in planning this option.

There are many commercially proven technologies for creating biogas and biofuel from either virgin or discarded biomass. A number of emerging technologies should also be considered for testing and development. Two levels of economic development can be pursued: (i) attracting companies that manufacture equipment, and (ii) developing the energy companies that use local biomass for generation. Some of the leading development opportunities in the region include

- ethanol fermentation plants using crop and food residues, or specific bioenergy crops using corn, cassava, coconut oil, etc. as an input (Box 8.4);
- facilities producing methane and fertilizer from animal manure or sewage sludge with anaerobic or aerobic digesters—generators can use the methane to produce electricity, as direct input to some types of fuel cells, or cracked to yield hydrogen for other cells;
- companies operating distributed methane producing systems, with equipment placed on large farms and dairies or next to sewage plants;
- fuel cell technologies to produce energy—hydrogen can be produced directly from some processes or from methane;
- firms manufacturing biomass processing

Source: AFP.

equipment, including fermentation equipment for ethanol, digesters to produce methane, generators to burn methane, and bulk materials transport and handling equipment; and

- farms growing dedicated crops for biofuel and biogas.

In addition, significant opportunities exist in Asia to retrofit existing and closed landfills to capture and treat methane emissions, a major GHG. Landfill gas (LFG) is a reliable and renewable fuel option that represents a largely untapped environmental and energy opportunity at thousands of landfills around the world. LFG systems collect and control gas emissions through a system of wells and prevent subsurface migration of gas off site. The most common market options for LFG are on-site power generation for on-site needs (leachate handling, lighting, etc.), power export to the grid, and short-distance transmission of low-to-medium heating value gas to adjacent industrial users.[243] In the future, the development of these landfills into bioreactors should further improve technical, environmental, and economic performances related to the production of biogas from waste. Projects to capture methane and carbon dioxide from landfills can be used to obtain emission reduction certificates under the CDM.

Government policies on energy and solid waste management can promote or hinder the beneficial use of LFG. Currently, most governments in the region have not enacted legislation requiring methane capture from existing or closed landfills. Project developers can be subject to different and sometimes conflicting laws at the local, regional, and national levels. Another important issue is the structure of energy prices. As countries begin to implement laws, regulations, and policies to improve solid waste management practices, promote alternative energy, and address GHG emissions, the economic viability of LFG energy projects will improve and investors can be

Box 8.4: Using Coconut Oil as Fuel in the Pacific Islands

Struggling with rising oil prices, Pacific island nations are increasingly looking to coconut oil, long a basic foodstuff, as an economically and ecologically sound petroleum alternative. Today, residents of the Cook Islands, Marshall Islands, Samoa, and Vanuatu use coconut oil as fuel for diesel engines, although on a relatively small scale. Trials have shown that a blend with diesel works best.

Coconut oil is seen as an inexpensive and efficient renewable energy source, particularly in Vanuatu, which has a population of 217,000 people and spends about 20% of its annual budget on imported petroleum. Increased reliance on coconut oil could help such island nations reduce their dependence on imported gasoline. It is cheaper, costing about $0.80 per liter compared with $1.17 for diesel. It also does not pollute.

And if it catches on as a fuel source, it could rescue Pacific island economies that have been hard hit by plummeting prices for coconut oil, one of their chief exports. However, the economics of using coconut oil for fuel are marginal, although the copra industry is already subsidized in many island countries, making diesel substitution more viable.

Ironically, the growth in the use of biofuels worldwide has helped push the price of crop oils higher and coconut oil now fetches nearly $1,000 a ton. There is a strong demand for vegetable oils in the United States and Europe. The Pacific island countries could get into a situation where they cannot afford to use the oil themselves and would profit more by sending their oil to other countries. One of the drawbacks of coconut oil, and one that will limit its export potential, is that it can be used as fuel only at a minimum ambient temperature of 17° celsius.

Sources: *Terra Daily*. 2005. Pacific Islands Look to Coconut Oil as Energy Saviour. 18 January. Available: http://www.terradaily.com/2005/050118033932.d0dgfeuw.html; Brooks, David. 2007. Pacific Islands look to coconut power to fuel future growth. Philippines Inquirer.net. 24 September. http://services.inquirer.net/print/print.php?article_id=90397

243 Nexant. 2004, November. *Study of the Market Potential for Recovered Methane in Developing Countries.* Prepared for USAID Global Climate Change Team. Available: www.usaid.gov/our_work/environment/climate/docs/nexant_mpm.pdf

more secure in the technical and policy framework that supports LFG energy projects.[244]

One important issue for project development is that open dumps and unmanaged landfills are the predominant disposal options in many developing countries. These sites can be less than optimal candidates for LFG energy development because they contain only small amounts of methane (resulting from aerobic degradation and rapid waste decomposition). However, many developing countries are currently transitioning to landfills from more uncontrolled systems. Sanitary landfills are a more environmentally sound disposal option for these countries, but they also will produce more methane.[245]

Another option for converting biomass to energy is waste-to-energy (WTE) conversion. At an incineration plant, combustion with recovery of energy involves treating waste to produce energy (heat, steam, or electricity) to supply other facilities or houses. The energy produced by waste incineration represents a significant proportion of energy needs in countries that have relatively high ratios of incinerated municipal waste per capita. In Japan, where the incineration market is currently estimated at $4 billion, 236 plants produce the equivalent in energy of a nuclear power station. Japanese companies are now beginning to build WTE plants in the PRC and Southeast Asia, where local governments are struggling to cope with overflowing landfills and huge volumes of waste. As part of its 10th Five Year Plan, the PRC will spend 50 billion yuan (CNY) ($6.5 billion) to construct municipal garbage treatment plants, half of which will be spent on incineration plants.[246] Japan is also building refuse-derived fuel (RDF) facilities (Box 8.5)

Many factors limit WTE operations using waste or refuse-derived fuel. Cost is one such factor. Combustion of municipal solid waste is a capital-intensive process, with net costs highly sensitive to the scale of operation and the revenues received for the energy recovered. In addition, in the developed world almost half the investment cost is in emission control systems. Another factor is the calorific power of waste, which is especially relevant in developing countries. For combustion technologies to succeed, they require about 2,000–3,000 calories per kilogram (cal/kg). Otherwise, auxiliary fuel has to be added. Indian garbage has an average calorific value of only about 800 cal/kg.[247]

Also, all the negative impacts of incineration need to be considered for WTE facilities. Conventional incineration facilities emit toxic compounds, such as dioxins and furans, heavy metals, and other pollutants. However, advanced facilities are now designed to optimize the volume of usable material outputs, as well as energy, making WTE a relatively safer option for countries that can afford high-end incineration technologies. Developers of WTE need to work closely with environmental and solid waste agencies and NGOs to ensure that the technologies are evaluated according to the strictest air, water, and solid emissions standards.

Finally, incineration even with the capture and use of the energy, is not necessarily the highest value use of the waste. Other options, such as composting and processing for chemicals recovery, may offer higher value, both financially and in terms of the efficient use of resources.

Bioproducts

Although bioenergy is receiving the majority of attention for utilization of both crop and residual biomass, biomaterials (or bioproducts) also present very positive opportunities for business development using this resource. As discussed on page 15, the world has witnessed a dramatically increased use of nonrenewable materials. Due to cost and/or more desirable properties, synthetic fibers have replaced natural fibers, synthetic oil has replaced natural oil, and plastic has replaced wood. However, rising concerns about future supplies of petroleum, along with high oil prices are stimulating interest and investment in renewable plant and crop-based sources.

A 1999 industrial chemicals and materials future scenario developed by the US Department of Energy

244 *Methane to Markets*. Available: http://www.methanetomarkets.org/landfills/landfills-bkgrd.htm

245 Ibid.

246 McIlvaine Company. 2004, Jan. *Scrubber/Absorber Update*. Available: http://www.mcilvainecompany.com/ sampleupdates/ScrubberAdsorberUpdateSample.htm

247 Toxic Link. 2005, *30 Apr. Campaign Against RDF and for Sustainable Waste Management in Delhi: Petition by environment, health, labour, civil society groups. Available:* http://www.toxicslink.org/alert-viewp.php?alertnum=6

Box 8.5: Refuse-Derived Fuel Facilities in Japan

Refuse-derived fuel (RDF) typically consists of pelletized or fluff waste that remains after the removal of noncombustible materials, such as materials and glass. The remaining material is then sold as RDF and used in dedicated RDF boilers or co-incinerated with coal or oil in a multifuel boiler.

There are more than 50 RDF-related facilities in Japan. One of these is located in Tado, Mie Prefecture. The Mie RDF power station has an output of 12,050 kilowatts, burning 200 tons of RDF a day at the maximum. The output is enough to meet the electricity demand of some 20,000 households. By using RDF produced in 26 municipalities in the prefecture, the power station can save energy equivalent to some 100,000 drums of petroleum a year, which means that Mie Prefecture will be able to reduce the emission of carbon dioxide equivalent to 0.6% of its target of carbon dioxide emission reductions.

In August, 2003, an explosion occurred at the Tado power plant due to inappropriate storage of RDF. This was one of a number of sequential troubles reported at RDF facilities, which resulted in strengthening technical and safety guidelines for RDF facilities.

Sources: *Kippo News.* 2002. Power stations using RDF comes on line in Mie. Vol. 9, No. 406. 11 December. Available: http://www.kippo.or.jp/KansaiWindowhtml/News/2002-e/20021211_NEWS.HTML; Institute for Global Environmental Strategies. 2003. Top News on the Environment in Asia. Available: http://www.iges.or.jp/en/pub/asia_2003.html

suggests what may lie ahead. The authors envisioned that 10% of industrial chemicals and materials would come from renewable resources by 2020, with as much as 45–50% from renewable sources by 2050. In the course of this coming biorevolution, there will be a relatively rapid shift to reliance on plant and crop-based resources for a significant portion of energy and chemical products.[248]

While it is unlikely that renewable materials will provide all of the basic building blocks of the future economy, the potential for bioproducts is vast and is far greater than is currently being realized. Using a number of current and developing technologies, an array of biobased materials—from forest thinnings and crop residues to animal and human wastes—can be transformed into a wide variety of products, including power, liquid fuels, plastics, chemicals, and chemical feedstocks (Figure 8.2).

Biomaterial opportunities range from relatively low-value composting of biomass to production of specialty materials for construction and green chemicals, such as:

- specialty paper mini-mills using fiber by-products such as rice or wheat straw;
- building products plants using fiber by-products, such as fiberboard, particle board, and laminated beams;
- biorefineries producing organic chemical feedstocks and products, such as feedstocks for chemical and other product formulation (e.g., polymers, nonpolymers produced from lignocellulose, or its components of cellulose, lignin, and hemicellulose); and final products, such as ketones, alcohols, glucose, furfural, and organic acids;
- bioplastic plants utilizing feedstock from the biorefinery;
- solid and liquid fertilizers from methane generators and biofuel processing plants;
- composting facilities; and
- animal feed production plants.

The bioproducts movement will have many advantages, but will also come with significant challenges. One of the many advantages is that the movement can be carbon neutral. The growth of replacement crops can sequester atmospheric carbon in a quantity equivalent to that released when the harvested crops are burned, representing a substantial advantage over the combustion of fossil fuels. At the same time, significant bioenergy production can only be obtained by bringing vast areas of land into production and using significant amounts of water, which may conflict with food security.[249]

248 US Department of Energy. 1999. *The Technology Roadmap for Plant/Crop-Based Renewable Resources 2020*. Office of Industrial Technologies, Energy Efficiency and Renewable Energy. Available: http://www.agrotechcommunications.com/pdf/technology_roadmap.pdf#search='Chemical%20and%20Material%20Demand%2010%%20from%20Renewable%20Resources%20by%202020'

249 Bowyer, J., J. Howe, P. Guillery, and K. Fernholz. 2005. *Bio-energy—Momentum is Building for Large Scale Development*. Minneapolis: Dovetail Partners. 20 May. Available: http://www.dovetailinc.org/documents/DovetailPulpPaper0705new.pdf

Figure 8.2: An Integrated Bio-Economy Has Many Facets

Integrated Biomass Production and Processing Systems

A successful biomass production and processing system needs to adapt to changes in supply and demand, including seasonal fluctuations. Seeing suppliers as a system and understanding the logistics of materials acquisition from these different sources help to support this adaptation. The outputs should include both energy and materials products, matched to market demand in the area. Planning for bioenergy and biomaterials should recognize the synergy and potential resource flows between the two types of facilities. With a systems approach, it is easier to define solutions that seek the highest-and-best reuse. It also supports incorporation of evolving technologies as they approach commercial feasibility.

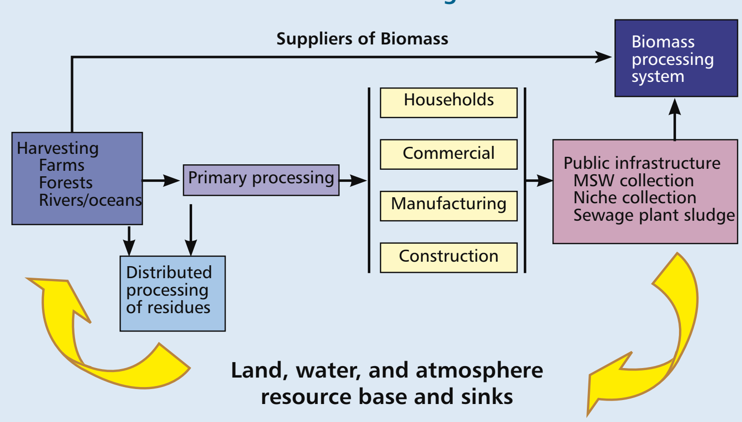
This complexity means that the potentials and problems of utilizing them demand a systems approach, not a piecemeal one (Figure 8.3). Economically feasible and environmentally sound recovery of these abundant resources depends on combining the best mix of low- and high-technology solutions in a system that optimizes use of the organic discards available. Some guidelines for optimizing production of biomass are provided in Box 8.6.

The business success of organic materials resource recovery may depend on the integration of networks of companies more than the establishment of large enterprises. The complex would incorporate plants performing different functions, including coordination and support, energy generation, and materials production. The diversity of sources, inputs, and products may be handled most effectively by this sort of value added network approach. The appropriate balance of companies in the complex would be determined by the supply and demand in the region—supplies available from virgin plant sources and discards of biomass from all sources as well as demand from markets for energy and materials.

An integrated biomass processing system would be analogous to a petrochemical refinery, with different units producing energy and material products through a sequence of refining steps (Figure 8.4). The primary difference is the high diversity of feedstocks and suppliers and the nature of the specific production processes. Some units in the system could be distributed to be close to supplies, such as digesters to produce methane from farm animal manure. Others would benefit from co-location, and possibly from integration with a standard petrochemical complex.

Such networks frequently function with a hub member that serves in a coordinating and resource-

Figure 8.3: System for Biomass Production and Processing



MSW = municipal solid waste.

Source: Lowe, Ernest. 2003. Report to the Dalian Development Zone on the Eco-Planning Process Phase 1. RPP International and Dalian University of Technology.

Box 8.6: Guidelines for Optimizing Production from Biomass

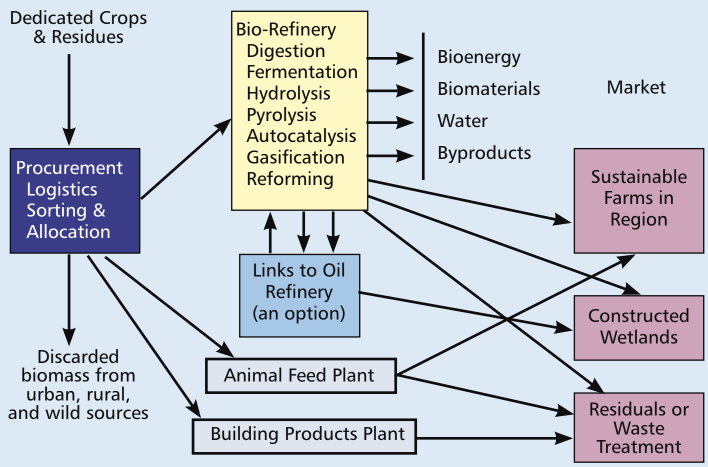
- In the allocation of discarded biomass resources, seek the highest-and-best reuse for each class of materials.
- Consider the business interests of traditional processors, such as composting lots and food waste collectors serving animal farms. These firms have a role in the whole system.
- Classify discarded organic materials as far upstream as possible to maximize resource value and allow strategic separation or blending, as technological choices dictate. Shipping costs, embodied energy, processing requirements, and impacts must all be considered in classification in the "high-to-low" or "upstream-downstream" continuum of relationships specific to a system for processing such materials.
- Many technologies that can recycle discarded biomass may also utilize crops grown for the purpose (e.g., soy, rapeseed, and others for biodiesel; sugarcane, corn, and cassava for ethanol; and production of organic chemicals). Design of resource recovery systems needs to balance the management of supplies from both discard and virgin resource streams. The redundancy of sources helps the system deal with short-term interruptions affecting any one supplier.
- Scale of operation is critical. Some technologies may not be feasible if resource streams are restricted to those available within a site, neighborhood, or industrial community. If, however, transportation costs, infrastructure, and administration allow absorbing materials from a broader region, some projects may attract a volume of supplies that is economically feasible (e.g., cooking oil from urban and institutional restaurants, wood and agricultural fiber wastes from forest or food processing operations).
- Distance is critical. Most supplies to a biomaterials processing system are bulky and of low value. Some technologies can and should be distributed systems, rather than centralized ones, particularly those with inputs from farms.
- Energy and water inputs are necessary to operate biomass recycling processes. Use of renewable energy inputs lessens the environmental burden of these forms of recycling. Where possible middle or gray water inputs should be used.
- In designing systems to utilize organic discards, consider the problems, needs and constraints that may be outside the usual scope of "waste management." These include water treatment, energy production, agricultural nutrient needs, soil amendment needs, landscaping, air quality, and neighborhood quality of life.
- Solving environmental problems of biomass recycling must be factored into economic feasibility analyses (e.g., prevention of sewage outfalls into coastal waters may avoid contamination loading, but may not be intrinsically feasible without accounting for the public-sector value of that diversion and treatment).
- Some counter-intuitive decisions may be valid, such as placing more organic waste of selected types into landfills that are well-designed to produce and capture biogas for fuel cells.

Source: Lowe, Ernest. 2003. Report to the Dalian Development Zone on the Eco-Planning Process Phase 1. RPP International and Dalian University of Technology.

allocating role, based on competitive bidding or a quota system. This logistic function is essential to the success of the whole system of businesses. The central coordinating organization would be responsible for optimizing flows to serve the whole system and balancing the needs of each member company. It could function in a brokering role or strictly as an enabling entity. The system needs to balance the need for long-term contracts between suppliers and customers with the ability to adjust flows based on seasonal variations in both supply and demand. As hub to a network of companies, this entity could also market products, as the firms choose. The coordinator could be a for-profit business or it might be an organization formed by the network to serve the common interests of its members.

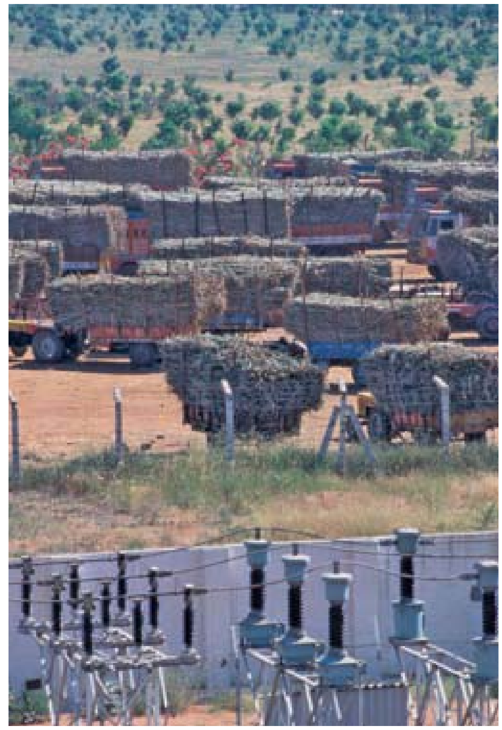
Clearly this model is more complex than planting huge monocultures of fuel crops and building single-function processing plants. It requires regional leadership, expert guidance, entrepreneurs committed to sustainable business, investors who are willing to learn how the complexity actually safeguards their capital, and widespread citizen participation.

Figure 8.4: Elements of Regional Biomass Processing for Optimal Utilization



with input from Anita Burke, the Catalyst Institute

Source: Lowe, Ernest A. 2007. Integrated Regional Action Planning of Biomass Utilization. Presentation to California Association of Resource Conservation and Development Councils Fall Conference, 25 April. Indigo Development.



Wastewater Reuse for Agricultural and Urban Uses

Countries that wish to pursue decentralized and integrated wastewater reuse as described in Chapter 7 will benefit from promoting system-level solutions. Knowledge and skill in the design of decentralized water treatment is an important asset, as is experience in getting the highest performance out of central sewage treatment plants.

Water management includes companies with products and services for

- a spectrum of filtration systems with costs and engineering appropriate for different flows;
- distributed sewage treatment systems that yield water suitable for secondary uses in the community;
- constructed wetlands for pretreatment of river water and/or for tertiary sewage treatment, through ecosystem processes on dedicated lands other than natural wetlands;
- living-machine water treatment systems that use ecological processes in closed environments;
- industrial, commercial, and home equipment that reduces water demand;
- engineering of secondary water distribution systems (gray or middle water);
- water purification technologies, including toxic cleanup and home purification; and
- coastal energy systems for water treatment (salt gradient solar ponds, tidal and wave energy, etc.).

Opportunities also exist for RSCOs that can provide packages of integrated solutions to a combination of industrial, government, and commercial clients. These can include design of water systems for new buildings, audits and rehabilitation plans, systems of water efficient hardware, conservation management practices, and system engineering. Components of this system include onsite, distributed treatment of water and sewage; minimization of water use; recycling of water used; and application of related renewable energy technologies. Unique synergies will develop when a variety of the best available practices and technologies and innovative business models are developed as a whole system. Thus, collaboration with energy service companies can generate synergies offering further cost savings.

Some countries are already getting much of their agricultural water from recycled and treated

Box 8.7: Ecosanitation in Nepal

The Environment and Public Health Organization (ENPHO) in Nepal is trying to revolutionize the way municipal governments approach their water pollution problems, in part by introducing ecosanitation (ecosan). For years, ENPHO has watched local governments struggle with the financial and technical capacities to manage the more modern and sophisticated sanitation and wastewater treatment systems that donor money has bought them. As an alternative, ENPHO works with communities and local governments to adopt low-technology sanitation solutions. The logic is to keep systems simple, affordable, and manageable.

Supported by the Asian Development Bank's Pilot and Demonstration Activities (PDA) program for water, ENPHO was able to install more than 150 ecosan units in low-caste households in the Kathmandu valley by the end of 2005. Ecosan is a dry toilet system that collects and recycles urine and feces separately as organic fertilizer and conserves the use of water. The basic principle of ecosan is to close the loop between sanitation and agriculture to help prevent diseases, protect the environment, conserve waste, and recover and recycle nutrients. Ecosan recognizes that human excreta is a resource, not a waste; that water is a precious resource that should not be used to transport excreta; and that excreta should be managed as close as possible to its source. After installation of these toilets, people in the communities are quite impressed with the technique and are demanding more.

Source: Alipalo, Melissa Howell. 2006. Simple, Low-technology Solutions to Sanitation Problems Offer Communities Affordable and Manageable Means to Improve Their Quality of Life and Environment. *ADB Review*. April-May. Available: http://www.adb.org/Documents/Periodicals/ADB_Review/2006/vol38-1/viable-alternatives.asp

wastewater. However, it is not cheap to restore water to a standard suitable for agriculture, especially if the water goes to irrigate food crops. The success of projects is greatly influenced by local circumstance and experience, but health and environmental precautions are always critical.

Many promising schemes involve recycling gray water from showers, kitchens, and laundry facilities into water fit for irrigating small market gardens. A research project initiated by IWMI in the Musi River area in Hyderabad, India, studied the importance of wastewater for the livelihoods of various groups of people. The study found that a wide range of income-generating and income-saving activities are sustained by wastewater irrigation. For example, using recycled water, para grass has overtaken paddy cultivation and can be harvested for more than 20 years without replanting. Wastewater is also used for fisheries and toddy.[250]

Small household and village gray water systems, as well as ecosanitation schemes (Box 8.7), can generate enough income to cover building and maintenance costs. The revenue gained from selling additional produce is often enough to encourage local participation. Where these systems replace septic tanks, households save further on the cost of pumping them out. As an added benefit, such projects frequently favor women because women play leadership roles in financing, operating, and managing both water treatment systems and market gardens.[251]

Sustainable Farming and Support Enterprises

The transition to sustainable agriculture appears to be inevitable due to the high consumption of fossil fuels in conventional farming, as discussed in the previous chapter. The transition to sustainable farming opens unique business development opportunities. The support system for sustainable farming requires new understanding and skills not usually available to the earlier providers of petrochemical materials and services.

Enterprises to serve sustainable farming include

- manufacturers of equipment and products that support sustainable farming:
  - o farm monitoring and information systems for efficient water and nutrient management;
  - o water and nutrient delivery systems;
  - o light-weight, low-impact, energy-efficient cultivation, harvesting, and hauling equipment;

250 International Water Management Institute (IWMI). *Smallholder Water Management Solutions*. Battaramulla, Sri Lanka. Available: http://www.iwmi.cgiar.org/smallholdersolutions/index.asp?nc=8851&id=685&msid=132

251 Conway, Kevin. *Local Solutions to the Global Water Crisis*. Ottawa: International Development Research Centre. Available: http://www.idrc.ca/en/ev-25649-201-1-DO_TOPIC.html

  - o organisms and services for pest management; and
  - o blends of custom soil amendments for high productivity and soil renewal.
- nursery for growing plants for farms, reforestation, and wetlands restoration;
- a farm marketing cooperative as the hub for distribution to local, national, and international markets;
- value-added food processing enterprises that improve returns to the local economy;
- laboratory to analyze soil, air, and water and suggest improvement strategies; and
- farm-scale energy systems to produce bioenergy from biomass residues.

Government support for the emergence of a sustainable farming business cluster is important to assist the farming industry to make the transition to sustainability and become more competitive.[252] Areas where policy and capacity development are needed are in:

- funding and providing research and training through government and university institutes and experimental stations;
- organizing training and agricultural extension services to support farmers in their adoption of sustainable practices;
- using government procurement to open markets for organic products;
- supporting development of sustainable farm exports through trade policy;
- coordinating the activities of agriculture, commerce, and environmental agencies; and
- managing publicly owned forests, parks, and farms according to agroecological principles.

High-End Technologies: Green Chemistry and Nanotechnology

Green chemistry, or sustainable chemistry, refers to the use of environmentally friendly chemicals and processes that reduce pollution and support environmental performance and resource efficiency of all manufacturers and users of chemicals. It emphasizes developing economically viable products and processes that require fewer reagents, less solvent, and less energy than conventional processes, while being safer, generating less waste, and having a lower environmental impact.

This field of innovation provides a basis for coordinating the work of government and corporate R&D centers, for process and product improvement in companies, and for stimulating development of new enterprises, especially in downstream specialty chemical companies.

Green chemistry R&D searches for new solutions in several basic areas, including

- changes in chemical process design:
  - o alternative pathways for synthesis that reduce pollution and energy consumed;
  - o alternative catalysts and reagents for chemical production processes;
  - o software tools for multivalue, complex process design; and
  - o analytic tools for monitoring and controlling processes.
- changes in manufacturing processes that use chemicals:
  - o process intensification, getting more output per unit of chemical input; and
  - o alternative catalysts, reagents, enzymes, and feedstock for specialty chemical companies and industry in general.
- new products that replace polluting chemicals:
  - o benign petrochemical products;
  - o liquefied and supercritical carbon dioxide;
  - o biomaterials such as bioplastics; and
  - o biofuels such as ethanol and methanol for direct use or as feedstock to provide hydrogen for fuel cells.

Companies in the green chemistry cluster support changes in cracking and synthesis processes and new product development for major petrochemical facilities. They also create their own new products from petrochemical feedstocks and renewable materials for the broader market.

The field of nanotechnology is another emerging high technology area, which may contribute substantially to environmental protection. Nanotechnology is the manipulation of materials

[252] Funes, Fernando. 2002. *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba*. Oakland, CA: Food First Books.

at very small scale,[253] where materials take on novel or unusual physical and chemical properties not experienced before. Nanotechnology will increasingly make it possible to allow molecule-by-molecule assembly of entirely new products, new components, new coatings, and surface treatments that are stronger, lighter, and more durable than products and materials currently available.

Governments, companies, and venture capitalists invested $6 billion into nanotechnology research in 2003 alone, producing daily breakthroughs. At least 300 products are already on the market, such as cosmetics, sunscreen, baby lotion, computer chips, paint, and other finishes. The National Science Foundation expects nanotechnology to grow into a $1 trillion market worldwide by 2015,[254] while Techcast studies forecast that nanotechnology will be used in 30% of all products by 2018, plus or minus 6 years.[255] Applications in the medical, environmental, and computer fields are especially promising.

Through application of nanotechnology, it may also be possible to reuse fibers indefinitely, which could revolutionize materials recycling. For instance, there are currently limits to how many times any specific type of paper can be recycled. Wood and other fibers from which paper is made are degraded each time they are recycled. In most cases the practical limit to reuse is 4–9 times depending on the type of paper being made. This translates to a loss of 12–50% of fiber delivered to a recycling mill each time that recycling occurs. The obvious implication is that a continual flow of virgin fiber is needed to replace fiber that is lost in the recycling process. Advances in nanotechnology suggest that it may be possible to repair recovered fibers through the addition of nanoparticles to damaged surfaces of wood fibers, which could someday enable unlimited reuse of paper.[256]

It may also become possible to use plant-derived materials in the manufacture of high-technology materials and products now made entirely from nonrenewable raw materials. In the longer term, increased understanding of plant biology and physiology, coupled with continued advances in nanotechnology, may lead to development of a vast array of products that self-assemble using little or no energy in the process.[257] If this occurs, it will have huge implications not only for the bottom line, but for society at large.

Given the likely impact of nanotechnology and the benefits in resource efficiency that may accrue from such technologies, countries in the region should support investments in nanotechnology research, especially research that focuses on increasing the use of biomaterials in nanotechnology applications. The PRC is already investing heavily and will soon surpass Japan's R&D budget.

However, application of nanotechnology should be carefully monitored and controlled. As a very new field with dramatically different technology and materials, the possible environmental and human health risks from nanotechnology are little understood at present. Application of the precautionary principle described in Chapter 3 is particularly important for nanotechnology innovations.

[253] The scale is between 1 and 100 nanometers. A human hair is roughly 100,000 nanometers wide.

[254] *BusinessWeek.* 2002. Nanotechnology. 25 March.

[255] ADB. 2005. *Asian Environmental Outlook: Making Profits, Protecting Our Planet*. Manila.

[256] Eadula, S., Z. Lu, G. Grozdits, M. Gibson, and Y. Lvov. 2006. Paper Properties that Can Benefit from LbL Nano-Assemblies. Forest Products Society 60th International Convention. Newport Beach, California. 28 June.

[257] Bowyer, J., J. Howe, K. Fernholz, and M. Wenban-Smith. 2006. *Nanotechnology and Forest Products Industry: Exciting New Products.* Minneapolis: Dovetail Partners. 26 September. Available: http://www.dovetailinc.org/documents/DovetailNanoTec0906.pdf.

Chapter 9. Supporting Industry Awareness and Change

More than 50 million companies are now operating in Asia, but few have been leaders in environmental performance. Many remain oblivious that their competitiveness is at stake. Countries must develop sector-specific programs for industry if they wish to promote more efficient resource use. Environment authorities will need to actively engage with the regulated community, including small and medium-sized enterprises, to agree on clear and fair targets for resource efficiency improvement.

This chapter focuses first on ways that governments can stimulate the adoption of appropriate practices on the part of industry. These include capacity-building programs, voluntary initiatives, and eco-industrial park development. The second focus is on tools and methodologies that industries can use to improve their resource efficiency.

Government Policies and Programs Targeted at Industry

A number of actions can help industrial and public facility managers understand the real costs of waste and the benefits they can gain from changing practices and technologies in their facilities. This will involve finding the optimal mix of environmental policy instruments, from conventional regulatory approaches and market-based instruments to new forms of public-private partnerships.

Some specific actions that governments can take are:

- Allow for market-based prices of commodities and other production inputs.
- Develop resource-based policies that set measurable goals for resource efficiency for each industrial sector and for government's own operations.
- Determine the appropriate level and mode of government agency involvement in assisting industry efforts, including the right balance between regulatory and voluntary programs.
- Formulate a cleaner production policy and/or law and voluntary programs for its implementation. This should include developing or strengthening the role of cleaner production centers and industrial associations in improving industrial resource efficiency through capacity development, outreach programs, and accumulation of lessons learned by peer networks. Support for SMEs should be a priority.
- Develop the physical and social infrastructure for resource recovery within and among companies, including eco-industrial parks and business incubators. At the same time, reframe waste management regulations to enable companies to exchange byproducts, with appropriate safeguards.
- Assist companies to integrate environmental management systems, green procurement, strategic R&D, customer relationships, supply chain management, and stakeholder dialogues.
- Develop government procurement policies that reward resource efficiency in supplier companies. This can be done by establishing new organizations, such as the Republic of Korea's "Green Product Promotion Association," or ecolabeling and certification schemes that guide both government and business procurement.
- Require companies or public facility managers to provide financial reporting on the costs of waste, the volumes of each type of waste, and the returns from resource optimization and recovery.
- Coordinate research by government, university, and private research institutes to advance the

technologies required.

- Set prices for utility energy and services on a quota basis, increasing costs for excess consumption rather than lowering them for high-volume use.
- Provide financial and social incentives to companies that excel in resource efficiency. These may be tax breaks, preference in government procurement, and recognition programs.
- Offer incentives and promotional programs for private investment institutions, encouraging them to make loans for facility retrofitting and high-performance design of new buildings and facilities.
- Create revolving loan funds (as public-private partnerships) to support the same types of loans, particularly for SMEs.

A number of the actions listed above were described in Chapter 4 on broad national policies. The following sections discuss four possible government actions specifically targeted at industry: capacity-building programs, voluntary initiatives, informational measures, and eco-industrial park development.

Raising Awareness and Capacity of Businesses

Persuading industries to improve their environmental performance can be difficult. Managers may believe improvements will simply add to the costs of production. They may have no accounting tools to identify the costs of waste and pollution because they are hidden in overhead. Or they may be simply unaware of new approaches, particularly if they run SMEs. Therefore, increasing resource efficiency depends on management awareness, capacity, and definition of responsibilities.

Disseminating best industry practices provide firms with both useful information that they can use to alter their own practices, and a reference point as to how they are doing relative to the industry. The practices may be defined by a government agency, or the government may provide assistance to industry sector institutes to identify and disseminate the practices.

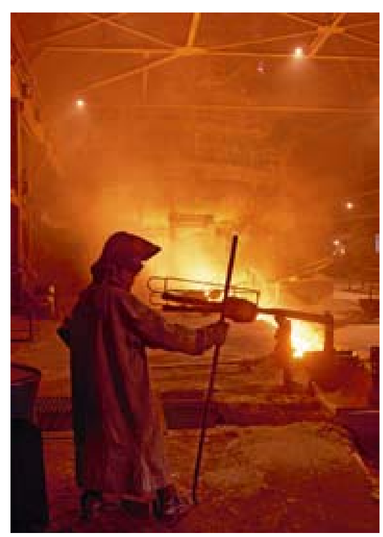
Management tools made freely available to firms can be of major assistance in understanding how to pursue greater resource efficiency and build systems awareness (Box 9.1) within the primary mandate of business survival.

Similarly, disseminating environmental performance of different technologies helps firms to identify the best technology to choose to meet their requirements. While technology vendors are the most common source of detailed information on technology, they are not impartial in comparing technologies, and it is important to the buyer concerned with environmental efficiency to have a neutral reference point. The performance information may be developed by a government agency, or the government may provide assistance and incentives to independent research institutes or to industry sector institutes to develop and disseminate the performance data.

Different types of organizations can help disseminate and showcase best practice, management tools, and technologies.

Information clearinghouses and networks develop and maintain databases on production techniques and environmental impacts of materials in different stages of their life cycle. They also create a forum for the exchange of practical experience and data, putting individuals with information directly in touch with those seeking it.

Extension services and technical assistance systems bring useful technical and management information directly to firms that are too small or cannot spare the management time to seek the information themselves. They may not have sought information also because they are simply not motivated to change, and a representative of an extension service or other assistance network on site in the enterprise may be able to interest the manager in practical terms of his own facility. The



Source: AFP.

Box 9.1: Building Systems Awareness

One goal of capacity-building programs should be to build systems awareness: the ability to perceive the dynamic interconnections among the elements of an issue or proposal. Systems awareness seeks to answer the following questions: How is the system of interest influenced by other systems? What impacts does it have on other systems? What are the needs one system fills for others?

There are simple process steps that can help groups think and work in a more integrative way.

- Begin by acknowledging that common sense is the basis of integrative systems planning. It is not high science to lay out a building in terms of the sun's path and the amount of exposure to solar rays in different seasons.
- Learn how other participants in a working group gather and process information. Inventory the sources of information each uses and what values they use in evaluating data.
- Assign a group member the role of remembering the larger context and looking for interactions with other systems. S/he can simply ask questions that broaden the view of the whole group.
- Exchange roles for a period of open exploration of the system under review. The economic development manager takes on the role of environmental protection. The investment analyst becomes the manager of a large sustainable farm. Each sees the world through the other's eyes.

Formal capacity-building programs for integrative thinking and planning might include the following activities:

- Contract university faculty and graduate students to study systems thinking and methods and adapt them to your culture's style of learning.
- Conduct workshops with international experts in such methods as transition planning and integrative regional planning.
- Highly participative workshops led by skilled facilitators can build capacity and at the same time advance understanding of a system. Some bilateral aid agencies,[a] nongovernment organizations, universities, and consulting companies have this sort of expertise.
- Assign key staff members to study the literature of systems thinking and planning and the websites applying it to sustainable development. They should attend workshops to develop skills in facilitating groups to work in an integrative way.
- Use information technology to support integrative planning.[b] For instance, simulation software supports "learning before doing" and geographic information systems allow one to view a region and overlay industrial, farming, water, soil condition, pollution sources, population and other data sets on it.
- Organize conferences in which participants play the key roles and agencies in a system of critical interest (like climate change or resource shortages) and simulate planning and decision making over one to two decades.

These process innovations can all be tried in the context of normal policy making and planning processes. They allow people to learn by doing what they normally do with a few modest changes.

[a] e.g., International Development Research Centre (Canada) and German Agency for Technical Cooperation (GTZ).

[b] Rejeski, David. 1998. Learning before Doing: Simulation and Modeling in Industrial Ecology. *Journal of Industrial Ecology* 2(4). Cambridge: MIT Press.

information provider could be part of an extension service offered through the ministry of industry or ministry of environment or it could be part of an industry sector program based in the sector institute or industry association. It could also use existing networks of technical assistance to business, such as may be operated by the electric power company.

Industry clubs or associations are a form of networking and are an effective means of promoting resource-efficient practices. They can be encouraged by providing the right regulatory incentives, usually at local government level, for establishing industry sector clubs and circles. The membership may be primarily representatives of firms, but it may also include a wider circle of parties concerned, especially when an industry has a significant effect on the welfare of a community. Government should provide grants and other incentives to these associations to develop practical management tools promoting resource efficiency, specially prepared for SMEs and as specific as needed to the issues and operations of a particular industry sector.

Demonstration projects showcase the techniques and cost-saving opportunities associated with various approaches to greater resource efficiency in selected plants. Government can promote targeted, high-profile demonstration projects in firms whose success will be credible to other firms in the sector. It is essential that effective mechanisms be built into the demonstration for the publication of the results within the sector, and that the host of the demonstration be chosen appropriately to the intended market (i.e., a large multinational company is not a credible demonstration for local SMEs).

In Malaysia, for instance, the Government is leading by example. In 2004, the Ministry of Energy, Water and Communications moved into the Low Energy Office Building, the first large government office building to be specifically designed as an integrated energy-efficient building and fitted with cost-effective features. The building provides a showcase for local professionals, academics, and industries for how to integrate EE into buildings. Another project is the Zero Energy Office Building which will consume less energy than it generates. The building, which will house Pusat Tenaga Malaysia (Malaysia's "one-stop energy center"), will be used as a demonstration project for building-integrated photovoltaics and will also be fitted with many cutting-edge EE features.[258]

Training facilities create the skilled human resources needed to implement resource efficiency strategies in firms. Government should promote effective training initiatives by establishing them in government institutes or by providing incentives to private training institutions and to industry sector organizations to do so.

There are good examples of government-funded capacity-building programs that have outreach programs serving the interests of constituent corporations (e.g., the Cleaner Production Centers that have been developed in many Asian countries). The best programs will facilitate industry-initiated activity rather than try to start change themselves. In addition, experience has shown that to be effective, such programs must be firmly grounded in an understanding of applicable market forces and thoroughly blended with other complementary policy measures.

One challenge that capacity building programs must overcome is that many companies are not aligned with an industry association. Few associations have adequate resources to actively seek out the many small companies in their sectors, and most commercially available tools are written to the level of sophistication and available resources of a large

Box 9.2: Targeting Small and Medium-Sized Enterprises in India

According to the Indian Ministry of Environment and Forests, small and medium-sized enterprises (SMEs) account for 40% of industrial production and are responsible for an estimated 70% of the total industrial pollution load nationwide. Thus, by expanding targeted monitoring and compliance assistance efforts to SMEs and clusters of small-scale industries, central and state boards could address a significant and growing pollution source.

As strongly advocated by the World Bank in its India Country Environment Analysis, a whole regulatory package should be put together by the central and state pollution control boards to target SMEs at the state and local levels, including

- a comprehensive inventory (to identify units that currently operate without consents);
- simplified monitoring procedures;
- environmental awareness raising; and
- technical and financial assistance programs.

Close cooperation with industry associations is essential in developing user-friendly technical guidance documents and setting up economic incentive schemes based on best practices that already exist in some states. However, compliance assistance would be effective only if there is a credible threat of detection and enforcement action against violators.

Source: Asian Environmental Compliance and Enforcement Network. 2006, November. *Environmental Compliance and Enforcement in India: Rapid Assessment.* Available: http://www.aecen.org/document.htm

[258] APEC. 2005. *APEC Energy Overview*. Tokyo: Asia Pacific Energy Research Centre/Institute of Energy Economics.

enterprise. Thus, capacity-building programs need to target SMEs (Box 9.2).

Self-Regulatory and Co-Regulatory Policy Instruments

With the growing appreciation of the limits of conventional policy instruments, many governments are encouraging the adoption of self-regulatory and co-regulatory policy instruments. The basic concept of voluntary initiatives is that more can be accomplished through a negotiated partnership than through enforcement of regulation alone. The government has the threat of regulatory enforcement, and the leverage of the firm is the need of government to achieve broad change in behavior.

Most voluntary programs take the form of partnerships between governments and the private sector. They come in an infinite variety of forms and include any relationship in which the government and a firm or business sector agree to mutually beneficial terms. As a result, the behavior of the firm changes toward greater resource efficiency. Examples include negotiated agreements between the firm and the regulatory body, auditable environmental management systems (e.g., ISO 14001), and public-private partnerships between industry and government or industry and civil society to achieve agreed objectives and self-enforced industry codes of practice.

Negotiated Compliance

In contrast to a specified compliance approach, negotiated compliance adopts a more cooperative approach between the regulators and the regulated in setting and enforcing standards. This shared responsibility between government and industry enhances the likelihood of a more open exchange of information between the parties and allows greater flexibility regarding the means of meeting a standard.

Moreover, a number of countries have started to develop regulations where attainment of certain targets (e.g., recycling targets) is required, while concrete means of achieving such targets are left in the hands of industries (nonprescriptive regulations). This, in turn, may increase the economic efficiency of the regulation and may be conducive to the adoption of innovative, preventative approaches to achieving the same environmental objective.

Negotiated agreements are between regulatory agencies and private sector enterprises. An enterprise either agrees to meet certain standards in return for specified incentives, or the mix of regulatory discharge limitations is negotiated, in which the firm may exceed one or more discharge limitations in return for better performance on others, the total being in the best overall interest of the environment and public health.

For instance, in the Philippines, DENR has recently put greater emphasis on encouraging industry groups to police their own ranks and come up with self-monitoring programs. Programs facilitate partnership with industry groups as well as regulations to require self-monitoring reports. The Philippine Environmental Partnership Program (PEPP) was designed to promote industry self-regulation. DENR provides technical assistance to help industries comply with regulations. For companies that have a strong compliance record, DENR provides incentives by relaxing reporting requirements or easing requirements for environmental compliance certificates, recommending preferential credit rating with partner government banks, and even providing financial incentives, such as tax credits, where allowed by law. For companies that are not in compliance but are committed to comply, DENR enters into an agreement with them, laying down a concrete plan and timetable to follow to come into compliance. According to representatives of a sugar mill that has had problems complying with water and air standards, participation in the PEPP helps them not only set a clear direction toward compliance but also projects a good image for the company, which makes it easier for them to deal with creditors and investors as they undergo financial rehabilitation.[259]

Auditable Environmental Management Systems

Resource efficiency in a company can be significantly improved by establishing an environmental management system (EMS) with challenging and comprehensive objectives, effective indicators, and structures assuring rapid learning and response. Managers should see ISO 14001 or any other EMS structure as the outline in which the team defines

[259] AECEN. 2004. October. *Environmental Compliance and Enforcement in Philippines: Rapid Assessment.* Available: http://www.aecen.org/document.htm

significant objectives and strategies relevant for the industry and its social and environmental setting. ISO 14001 is increasingly important in international trade.

To support monitoring and enforcement efforts, the state of Gujarat in India has introduced an environmental audit scheme aiming at ascertaining the performance of environmental management systems in various industries in the state. One objective of the program is to arm the Gujarat PCB and the association of industries with necessary performance information to support compliance monitoring.[260] Introduced under the directions of the High Court of Gujarat and implemented under the direction of a technical committee consisting of experts from the National Institute of Occupational Health, Central PCB and the government of Gujarat, the scheme requires industries to submit an annual environmental audit report through designated auditors recognized by the board. If a specified industry does not submit its audit report according to the prescribed time schedule, the board issues a notice of direction to the defaulting unit, failing which, the Gujarat PCB can request the concerned authority to disconnect water or electricity services. According to the Gujarat PCB, the environmental audit scheme has resulted in improved compliance and enforcement of environmental laws, creating an effective mechanism for supplementing legal monitoring of industries with a third-party audit.[261]

Major multinational companies require their suppliers to develop a certified EMS through supply chain relationships, often called greening the supply chain (section below). For many Asian suppliers, it has become a basic condition of doing business. Government also has a potential role in promoting EMS, by linking EMS adoption with permit requirements, introducing related flexible penalty systems, and/or ensuring that future updates of EMS standards have an increased emphasis on resource efficiency and enhanced environmental performance.

EMS should be more than just an administrative exercise. Without an overriding goal of improving resource efficiency (going beyond regulations), an EMS may result in a formal system that, while matching the requirements for certification, may simply define performance objectives and indicators that do no more than keep operations in compliance with regulations.

Greening the Supply Chain

Greening the supply chain (GSC) means looking not only at the environmental practices of a particular company, but also at those of its associated suppliers and vendors. In this way, buyer companies seek to ensure that the environmental standards they have adopted internally are consistently maintained by their suppliers. Even without government regulation, this sort of inter-firm compliance regime gives advantages to supplying companies that adopt greener practices.

Currently, many large multinational corporations have adopted green supply chain standards and enforce them through inspection and compliance regimes, but they also offer assistance to suppliers to help them achieve the more rigorous standards. Interest in green supply chain management and its implications for industry suppliers is growing in Southeast Asia and the PRC, as large companies seek to protect themselves from increased liability while protecting the environment. Some NGOs are also promoting this practice (Box 9.3).

In addition to helping spread EMS throughout the region, DfE is also spreading through the region through supply chains. In response to RoHS legislation (page 64), many Japanese electronics corporations and Japan-based foreign multinational corporations have issued public statements or policies reflecting the companies' commitments to incorporating DfE elements in their product design systems. These voluntary industrial standards are spreading by supply chain relationships, such as Sony's "Chemical Substances Management Standards" and Matsushita's "Green Procurement Standards" and "Chemical Substances Management Rank Guidelines."

Voluntary Agreements

Voluntary agreements involve companies agreeing to achieve significant goals in waste reduction and other aspects of resource efficiency in exchange for improved public recognition, access to governmental technical assistance, and cost savings. Most voluntary instruments are funded through partnerships

260 AECEN. 2006, November. *Environmental Compliance and Enforcement in India: Rapid Assessment.* Available: http://www.aecen.org/document.htm

261 Ibid.

Box 9.3: A Philippine NGO Supports Green Supply Chain Management

Recognizing that buyer companies are increasingly concerned with their suppliers' social and environmental performance, the nongovernment organization Philippine Business for Social Progress initiated the Green Supply Chain Project. The project has identified environmental benefits as well as cost savings and strategic and competitive advantages for greening the supply chain as described below.

- **Economic benefits from increased efficiency.** Reduced wastes means decreased handling expenses, fines, and even costly inputs. Suppliers' savings may be passed along to buyer companies.
- **Competitive advantage through innovation.** Efficient production is enhanced through use of cleaner technologies, process innovation, and waste reduction. Reduction in wastes equals money earned.
- **Improved product quality.** Supply chain partnerships help maintain relationships between buyers and suppliers leading to increased control over product quality.
- **Consistent corporate environmental goals.** Companies enjoin suppliers and business partners to practice good environmental management to address corporate environmental goals.
- **Improved public image.** Consumers, investors, and employees respond positively to companies with a reputation for good environmental performance.
- **Risk management.** Decreases the liability and risk of interrupted service due to supplier's environmental practice.

Source: Philippine Business for Social Progress. Available: http://www.pbsp.org.ph/greening_the_supply_chain_business_case.htm

between governments and the private sector. In some cases, and particularly with capital-intensive projects in developing countries, multilateral donors or international organizations are major financial contributors.

Voluntary agreements are almost nonexistent in Asian countries, even though they are quite common in other regions, especially Europe and North America. The PRC uses voluntary agreements as a policy tool to increase industrial EE. The first agreements were signed with Jinan Iron and Steel Company and Laiyang Iron and Steel Company in April 2003. Both plants agreed to increase their efficiency efforts to achieve by 2005 a level of efficiency equal to the advanced international level in 2000. A recent performance review showed that both plants were well on their way to achieving these targets. The experience in this pilot laid the foundation for the expansion of the approach to the national iron and steel sector, as well as to the petrochemical sector, with support from the GEF.[260]

Some voluntary instruments are now becoming mandatory policies. This applies specifically to energy-efficient equipment labeling, standards, and various emission targets. In Asia, however, this shift has had less impact because these voluntary instruments are not yet widespread.[263]

Industry Codes of Practice

Industry codes of practice provide broad guidelines to firms for a management approach that addresses issues of environmental sustainability as part of core business decision making. Examples include the International Chamber of Commerce's Business Charter for Sustainable Development, the chemical industry's Responsible Care Program, and the Japanese business sector's Keidanren Global Environmental Charter. For these codes to be effective, mechanisms need to be in place to promote members' implementation of the code, to monitor and publicly report on adherence, and to have meaningful business sanctions in addition to peer pressure.

Japanese manufacturers have established the Japan Article Management Promotion-consortium (JAMP) to help them comply with REACH and other chemical-related regulations, such as RoHs and

[262] Lawrence Berkely National Laboratory, China Energy Group. 2005. Available: http://china.lbl.gov/china_industry-iee-va.html

[263] UNEP. 2006. *Improving Energy Efficiency in Industry in Asia: A Policy Review*. Bangkok, Thailand.

WEEE. JAMP provides a practical means of orderly management and the smooth disclosure and transfer of information on chemical substances and other data contained in components and products. JAMP tries to establish common forms of substance information to share among manufacturers and suppliers to help them reduce their costs and burdens. Along the increasingly globalized supply chain, voluntary initiatives for information sharing and harmonization, such as JAMP, are also likely to expand beyond borders (page 161).[264]

Moreover, the Japan Electrical Manufacturers' Association Environmental Action Plan highlights industry efforts to create "a resource-circulating society," and the Association for Electric Home Appliances has recently begun making public on its Japanese website the voluntary DfE initiatives that its members are undertaking.[265]

In India, one voluntary initiative aimed at reducing industrial pollution is the Charter on Corporate Responsibility for Environmental Protection. In 2003, the Ministry of Environment and Forests (MOEF), and the Central Pollution Control Board (CPCB), in consultation with industry, launched the charter to promote waste minimization and adoption of clean technologies. Eight task forces comprising representatives of the MOEF, CPCB, state pollution control boards, industry associations, and experts monitor implementation of the charter. The charter recognizes that some of the 17 category sources were not in compliance with all requirements and set new industry sector-specific compliance dates. As part of this process, noncomplying facilities submitted bank guarantees with their action plans.[266]

Informational Measures Targeting Industry

Governments can further stimulate the adoption of appropriate industrial practices through informational measures. Action can be taken in a variety of areas, including ecolabeling schemes, public disclosure of firms' environmental performance, energy audits, and environmental accounting systems, as described below.

Ecolabeling

Product labeling is most significant in international trade with industrialized markets, but is having a slowly increasing effect as well on domestic purchasing choices. There are various such schemes worldwide and the ISO 14000 series of guidelines is trying to bring some coherence to the many definitions. There is a proliferation of ecolabeling schemes in Asia and the Pacific (Table 9.1). For a discussion of EE labeling, please see page 78.

There is also a growing movement to harmonize environmental label programs within the region with the help of the Global Eco-labeling Network. As of 2003, Japan; Republic of Korea; Taipei,China; and Thailand had joined the Common Core Criteria for Asia Countries. Currently, the mutual recognition system is done on a project basis, such as the common core criteria for paints and toner cartridges. Certification standards will be unified step by step from the national to the regional and eventually to the international level.[267] While this prospect is still far off, harmonization could one day help make ecolabeling a powerful global tool to encourage sustainable consumption.

Another important trend is the strong relationships that are beginning to form between ecolabeling organizations and procurement programs. For instance, the Japanese Government established guidelines for green procurement and referenced the Eco Mark as one possible source of information. Subsequently, many local governments in Japan established green procurement guidelines that also referenced the Eco Mark.

For the most part, however, the implementation of ecolabeling schemes has been a challenge in the region. Some are seen to distort the market and conditions for fair competition, especially in product groups where national producers compete with foreign products. Another challenge is the verification of the environmental features of a labeled product.[268]

264 International Symposium on Chemicals Management in the context of Global Trends "EU REACH and Japan's Response," Japan Article Management Promortion_Consortium website

265 EcoTrack. Available: http://www.eco-track.com/regions/region_detail.php?id=1

266 AECEN. 2006, November. *Environmental Compliance and Enforcement in India: Rapid Assessment.* Available: http://www.aecen.org/document.htm

267 Green Council. 2003, 15 Feb. The Seminar of "Common Core Criteria of Eco-labelling Scheme." Available: http://www.greencouncil.org/web/ publications_articles.php?id=1&art_id=227

268 ADB. 2005. *Asian Environmental Outlook: Making Profits, Protecting Our Planet*. Manila.

Table 9.1: Ecolabels in Asia

Country	Organization	Ecolabel	Summary
Australia	The Australian Environmental Labelling Association Inc.	The Australian Eco-label	• Launched in November 2001 • 26 companies certified; standards developed for 30 types of product categories[a]
China, People's Republic of	China Certification Committee for Environmental Labeling Products[b]	Ten-ring Mark	• Established in May 1994 • As of May 2003, 527 Chinese enterprises and a total of 3,426 products had been certified [c]
Hong Kong, China	Green Council and Hong Kong Productivity Council	Green Label Scheme	• Green Council formed in 2000 • 9 categories comprising 37 products open for application[d]
India	Central Pollution Control Board	Ecomark Scheme	• Launched in 1991 • 16 product categories
Japan	Japan Environment Association	Eco Mark	• Second oldest program, established in 1989
Republic of Korea	Korea Environmental Labeling Association, Korean Ministry of Environment	Environmental Labeling Program	• Launched in June 1992 • 2,041 certified products (506 companies) in over 100 product categories
Malaysia	Product Certification Program	SIRIM[e] Quality Assurance Services	• Launched in 1996
New Zealand	Environmental Choice New Zealand	Environmental Choice New Zealand	• Over 200 products in 29 product categories[f]
Singapore	Singapore Environment Council	Singapore Green Labeling Scheme	• Launched in May 1982 • About 300 products in 32 categories[g]
Taipei,China	Environment and Development Foundation	Green Mark Program	• Launched in August 1992 • Nearly 1,400 products certified in 87 product categories[h]
Thailand	Thailand Environment Institute	Green Label Program	• Launched in August 1994 • About 144 products (and 29 companies) in 16 categories[j]

[a] Australia Environmental Choice. Australian Environmental Labelling Association, Inc. Canberra. Available: http://www.aela.org.au/homefront.htm

[b] Third-party certification program under the direction of the China State Bureau of Technology Supervision and the National Environmental Protection Agency.

[c] Qing, Xia and Yu Jie. 2003. China's Environmental Labeling Program. Presentation at Challenges Ahead on the Road to Cancun, World Trade Organization, 16–18 June.

[d] Law, Ir Nelson. 2003, August. Green Label : *HK Green Label - A Product Certification Scheme using Green Criteria.* N. Law and Associates Management Consultancy. Available: Ltdhttp://www.nlaw.com.hk/articles_detail.asp?Article_id=35

[e] Standards and Industrial Research Institute of Malaysia.

[f] Environmental Choice New Zealand. Available: http://www.enviro-choice.org.nz/

[g] United Nations Environment Programme. 2004. *Regional Sustainable Consumption and Production Report: Asia and the Pacific.* Paris.

[h] Greenmark. Environmental Protection Administration. Hsinchu, Taipei,China. Available:http://greenmark.epa.gov.tw/english/index.asp

[i] Bunyagidji, Chaiyod. 2004. Presentation on Green Procurement in Thailand: Challenges and Opportunities for *APO Workshop on Green Procurement.* Kuala Lumpur, Malaysia. 3 September.

Publicizing Environmental Performance

The widely accepted idea of citizens' right to know has both paved the way for the use of public disclosure programs that publicize compliance information of individual polluters. Another important aspect is that information collection is a first step toward the possible introduction of other policies at a later stage. A feature that has made disclosure schemes very attractive to policy makers is their low cost. A properly managed and relatively small infrastructure for collecting and disseminating information is generally sufficient for implementation.

Governments can publicize environmental performance to encourage (or discourage) certain industry behavior in various ways. Four of these are described below.

Toxic release inventories and pollutant release and transfer registries. These create a public record of the environmentally threatening raw materials used by a firm and of the discharges by the firm to the environment. They have been successful in the Australia, Canada, United Kingdom, and US, and through mandatory environmental reporting in Denmark. Requiring public disclosure of information on environmental performance by any means, including establishing a pollutant release and transfer register, stimulates greater voluntary corporate reporting. While originally intended as a means of public monitoring of corporate performance, reporting procedures have also brought about substantial voluntary change in firm behavior by managers who, before being required to report their discharges, often did not realize how inefficient their processes were.

Corporate reporting. Corporate reporting of general environmental performance should be encouraged by government, both to inform the affected public and to force firms to focus on their performance. One lever available to government is to require audits of environmental performance as part of the permitting requirements. Firms may be mandated to undertake audits of their plants and to implement some of the audit findings. In terms of integrated permit conditions, firms may be required to implement a structured environmental management system and to make public information on their environmental performance. Government can also achieve this end through a combination of requirements and tax rewards for compliance or exceeding requirement.

Public recognition and awards. Recognition is an effective means to reward accomplishment by business, giving them visibility and a valuable public relations asset. Issuing high-profile awards for enterprises that have effectively achieved greater resource efficiency may be carried out by a government agency, such as the ministry of industry, a regulatory agency, an industry association, or a prestigious neutral body, such as a foundation. In any case, the government can offer incentives associated with the reward, such as fast track licensing or less frequent compliance monitoring.

Corporate environmental performance ratings. These ratings provide a forum in which firms can compete for recognition for their accomplishments toward environmental or sustainability performance, and in which firms that do not take the issue seriously can receive a poor rating and risk public embarrassment. Public disclosure programs in some Asian countries (PRC, Indonesia, Philippines, and Viet Nam) have introduced a rating system for the most important industrial polluters based on self-reported and inspection data. Such systems can offer a compliance incentive and benchmarking tool for industry, an information source and accountability vehicle for the public, and priority setting aide for environmental agencies.[269] For instance, the PROPER initiative in Indonesia selected the firms to be rated (Box 9.4). An alternative approach is to have firms volunteer to be in the rating system because they want the public recognition of a good rating.

Environmental Accounting Systems

Standard management accounting usually buries waste costs in overhead costs where they are not visible to management. Usually no one is responsible for more than disposal or pickup of wastes by recycling companies. Thus, capacity-building

[269] AECEN. 2006, Nov. *Environmental Compliance and Enforcement in India: Rapid Assessment.* Available: http://www.aecen.org/document.htm

Box 9.4: Indonesia's PROPER—Pollution Control Evaluation and Rating

Launched in June 1995, Indonesia's Program for Pollution Control Evaluation and Rating (PROPER) was the first major public disclosure program in the developing world. Although it collapsed in 1998 with the Asian financial crisis, it is currently being revived, this time on a larger scale.

The PROPER scheme targeted major industrial water polluters and used a five-color scale to grade the environmental performance of different facilities. Four rounds of evaluations were released to the media over the 3 years that the program ran.

Indonesia's environmental authority, BAPEDAL, went to great lengths not to alienate or provoke industry but to be constructive and provide accurate and timely advice about what firms had to do to improve their ratings. Since industrial leaders were very influential during this period, there was also a conscious media strategy for the release of information and other aspects of public relations related to the program

A 2004 assessment of the program by Resources for the Future showed that there was a strong, positive response to the scheme, in particular among firms with poor environmental compliance records. These firms cut their emissions intensity by approximately a third. The response was immediate, and firms pursued further reductions in the following months.

Source: Lopez, Jorge Garcia, Thomas Sterner, and Shakeb Afsah. 2004 October. *Public Disclosure of Industrial Pollution: The PROPER Approach for Indonesia? Resources for the Future.* Washington, D.C. Available: http://www.rff.org/documents/RFF-DP-04-34.pdf

programs should stress environmental accounting systems and useful management approaches to support improvement in source reduction and by-product utilization, such as[270]

- developing database inventory of every unmarketed by-product (waste);
- giving every by-product flow a product number and a line in the cost-accounting books (material, energy, or water);
- assigning a manager the responsibility of managing by-products and encouraging innovations to eliminate them, finding internal uses, and/or marketing them externally; and
- seeking the highest and best use for the unmarketed products, internally or externally.

With these changes in organization, plant managers can see the real costs of producing unmarketed products and someone has the job of dealing with them so as to add to the bottom line. This person is looking at the overall picture of by-product mass, energy, and money flows, and balancing revenues and costs to discover the highest value use of these products. His or her assignment is: either find a way to stop making unmarketed products or find a way to use them, internally or externally.

Environmental management accounting provides the firm with an understanding within its overall corporate accounting system of the cost of regulatory compliance and of otherwise managing its environmental issues. Only with such information can the business decision maker compare the cost of a particular process improvement or environmental management action with the cost reductions or other benefits that will be gained. Governments may promote the use of environmental management accounting through education and awareness programs directed to business; in certain circumstances it may require an environmental management accounting report by the firm.

Eco-Industrial Park (EIP) Development

PRC, India, Japan, Republic of Korea, Thailand, and other Asian countries have established programs to transform existing industrial parks or estates into eco-industrial parks (EIPs). In a few instances, these programs aim at developing new parks, but most have started by implementing industrial symbiosis, seeking exchange of by-products among companies. Location in an EIP can provide business opportunities and support for new or expanding environmental

[270] Lowe, Ernest. 2001 and 2005. Interviews with Douglas Holmes, chemical engineer and co-author of the first *Eco-industrial Park Handbook,* and with Aldrin Bayer, strategic consultant in by-product utilization for the steel industry, former manager at Suprachem, a South African steel by-product recycling subsidiary.

enterprises, as well as standard manufacturing and service companies.

The definition of an EIP from the ADB Handbook[271] is as follows:

> "An eco-industrial park or estate is a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its individual performance.
>
> "The goal of an EIP is to improve the economic performance of the participating companies while minimizing their environmental impacts. Components of this approach include green design of park infrastructure and plants (new or retrofitted); cleaner production, pollution prevention; energy efficiency; and inter-company partnering. An EIP also seeks benefits for neighboring communities to assure that the net impact of its development is positive."

This systems understanding implies a mission for EIPs:

> "An eco-industrial park will achieve profitable return on investment while demonstrating an environmentally and socially sound form of industrial real estate development (or redevelopment). This model of industrial development will be a major hub for sustainable regional development.
>
> "Profit for public authorities includes local ventures developed, foreign direct investment attracted, new jobs created, and environmental and social benefits. Nevertheless, publicly-owned EIPs should generate sufficient revenue to pay their own operating costs."[272]

To achieve this mission, EIPs may create by-product exchanges among companies as one of many strategies to optimize resource consumption and reduce pollution in an industrial park or region. Some projects emphasize this approach over all others. EIP teams benefit from seeing the overall EIP system as one for optimizing all resource flows in an industrial park while reducing all environmental and social impacts. The system includes:

- implementation of cleaner production within plants and utilities and promotion of eco-efficiency through source reduction, reuse, internal recycling, and product and process design;
- company-to-company by-product exchanges to handle a share of their unused by-products; and
- an integrated resource recovery system to optimize use of all external resource flows and of all by-product resource flows.

EIP planners apply principles and practices of industrial ecology to the park infrastructure and buildings. Effectively, this organization provides opportunities for cleaner production, technologies for renewable energy, advanced water management strategies, and ecological landscaping. Thus, resource efficiency is embodied in the physical plant itself. A good example, based on water recycling in an EIP in Thailand, is given in Box 9.5.

Development of EIPs offers business opportunities in real estate development.[273] In Asian countries structured to allow private land development, such as in India, Philippines, and Thailand, this infrastructure for business operation enables developers to profit from the appreciation of land, tenant leases or purchases, and business environmental services. In the PRC, industrial zones are generally owned and managed by the government so the returns are from sale or leases, foreign direct investment, and the social goods of new enterprise development and employment opportunities.

271 Lowe, Ernest A. 2001. *Eco-Industrial Park Handbook for Asian Developing Countries*. Prepared for the Environment Department, Asian Development Bank. Available: www.indigodev.com/Handbook.html.

272 Ibid.

273 Ibid.

Box 9.5: A Closed-Loop Water System in Thailand

Management at the Eastern Seaboard Industrial Estate has created a closed-loop water system at this site southeast of Bangkok. The estate manager, Hemaraj Land and Development, initiated the system design from the beginning of the planning process. It was essential to invest early in capacity and alternative piping so that the water infrastructure could accommodate all necessary processing for reuse.

The estate's companies use a total of 36,000 cubic meters (m^3) of water each day, with supplies coming from reservoirs in the region fed by rainfall. Nearly all factories in the estate are required to maintain their own pretreatment plant, after which their wastewater flows to primary and secondary aerated lagoons. (The estate maintains an inorganic waste-water treatment plant and an emergency pretreatment plant in case of breakdown of the factories' plants.) A constructed wetland provides tertiary treatment and a holding pond (600,000 m^3) which cleans the water to higher than the Industrial Estate Authority standard. Plants in this wetland are selected to remove residual heavy metals remaining after earlier treatment.

The holding pond is the last piece in the system. From here the water goes through a dedicated retreatment plant process and returns to a supplementary system of pipes that the estate uses for landscaping and to supply several factories using it for cooling. Management is researching the feasibility of using the recycled water for growing rice on adjoining farmland. A U-ditch drainage system manages storm water and will be integrated with the recycled water system in a next step of development.

The holding pond is home to 300,000 fish and diving ducks. The fish cannot be marketed for human consumption because they contain significant amounts of heavy metals, but management is exploring the possibility of supplying them to an alligator farm in the Rayong region. During the winter, migratory water fowls use the pond as a resting place.

The estate engineers are testing a new treatment method, known as a reed-bed purifying system. This will use gravel-filled ponds with floating islands to grow tropical flowers for market. The flowers, other plants, and fixing bacteria will aerate wastewater, possibly replacing the mechanical aeration ponds and cutting the cost of their energy usage. Proceeds from export sale of the flowers will fund local education programs.

Source: Lowe, Ernest A. 2001. *Eco-Industrial Park Handbook for Asian Developing Countries*. Prepared for the Environment Department. Manila: Asian Development Bank. Available: www.indigodev.com/Handbook.html

A specific source of sustainable investment is emerging around the need for reductions in GHG emissions. Management of an EIP could coordinate GHG credit trading for resident companies and others in the region, sharing in the financial returns. Another potential source of return to the continuing management team is fees for supporting exchange of by-products among tenants.

EIPs yield both private and public benefits, suggesting that project financing and other support should come from a mix of private, public, and civic (e.g., foundations and other nongovernment funds) sources. The balance between the two will vary by project.

- An EIP project may benefit from finance from public and civic sources in its predevelopment and design phase. The park may fully qualify for private sector funding in the actual development of the site; however, public sources, such as industrial development agencies, should also be evaluated.
- The financing of tenant enterprises and their facilities will generally come from private equity and debt capital sources, although the public sector may provide environmental industry investment funds, development bonds, or other forms of public support.
- Support structures like the incubator and training center generally qualify for funding from government or international banks and/or bilateral development agencies. Because they will benefit recruitment to the property, it is appropriate that the EIP's private investors should also contribute to their success.
- Community development initiatives may also be largely financed from public and civil sector sources, with contributions from the EIP development budget (as part of its investment in mitigating the impacts of development).

This blending of different public, private, and civil sources of support suggests that the EIP developer should form a number of overlapping public-private partnerships with members appropriate to each level of the project. For instance, the developer could seek support for feasibility planning of the EIP from development banks, multilateral banks and aid organizations, and national industrial development or economic development agencies. Where the development includes employee housing, national housing authorities may also help. Generally international funds have to go through a government entity, which then creates a joint venture with the development company. The public benefits of the EIP in economic development, job creation, and superior environmental performance would repay this public investment. The completed feasibility study then becomes the basis for private investment to develop the infrastructure for the park.

If the government owns and develops the land, the investment picture is usually quite different. The high priority benefits are attraction of foreign direct investment, development of new local enterprises and expansion of existing ones, and creation of jobs. As an EIP achieves these goals, along with improvement of the industrial and agricultural environmental performance, the public agency may not be required to achieve the usual financial returns on investment. This is especially true when the park management offers tenants low rent, tax holidays, and other incentives. A publicly developed enterprise can generate the same variety of revenues as a private one; thus, a useful policy is to require management to calculate a bottom line, showing total financial, environmental, and social return on investment.

Resource-Efficient Tools and Methodologies

Various approaches to reducing industrial pollution and resource use—such as cleaner production, eco-efficiency, and industrial ecology—have been developed and pursued by different organizations, each targeting some aspect of improving the resource efficiency of the production of goods and services. Many of these approaches share the common goal of reducing risks and fostering the sustainability of economies and the environment. In this they also share the goal of achieving maximum efficiency in the way economic processes use natural resources.

Perhaps the biggest contributions of these approaches is that, together, they have provided a suite of methods and tools to help companies and utilities take responsibility for their products and services over their full life cycles. Such methodologies include industrial metabolism, material flow analysis, DfE, dynamic input-output analysis, industrial symbiosis and by-product exchange, systems engineering, and logistics engineering. This section describes some of these methodologies.

Proactive corporations and agencies that adopt these resource-efficient methodologies and invest in new technologies have the opportunity to turn environmental problems and constraints into profitable or financially beneficial outcomes. Increased productivity of resource use, product differentiation, and risk reduction are essential strengths for operating in a global economy.

The benefits of investment in resource efficiency are demonstrated by the experience of developed countries over the last 35 years. Whether the product is electricity, steel, paper, chemicals, or other commodities, industry has developed new and improved manufacturing and processing systems that make products using fewer natural resources and generating less pollution per unit of output. Through these changes, companies have complied with regulations and met or exceeded internal performance targets at a lower gross cost (e.g., operating, maintenance, disposal, and penalties).

Product-Life Extension and the Service Economy

The concepts of product-life extension and the service economy go beyond all other industrial ecology approaches to closing the loop in industrial or consumer systems. Companies can realize cost-savings in materials, energy, transportation, consumables, and the need to manage the eventual disposal and/or recycling of a physical product through various strategies.

Product-life extension implies a fundamental shift from selling products themselves to selling the use of products, the customer value they yield. This change in the source of economic value to firms depends on

Box 9.6: Dematerialization and Recycling in Building Construction

Construction waste recycling is the separation and recycling of recoverable waste materials generated during construction, remodeling, and demolition. Packaging, new material scraps, and old materials and debris all constitute potentially recoverable materials. In renovation, appliances, masonry materials, doors and windows are recyclable.

Some materials can be recycled directly into the same product for reuse. Others can be reconstituted into other usable products. Unfortunately, because of a combination of processing costs and transportation costs, recycling that requires reprocessing is often not economically feasible unless a user of the recycled resources is located near the material source. Many construction waste materials (such as dimensional lumber scraps) that are still usable can be donated to nonprofit organizations, keeping the material out of the landfill and supporting a good cause.

The most important initial step in a strategy to reduce construction waste is to reduce the amount of waste through good planning. Design should be based on standard sizes and materials and should be ordered accurately. The use of high-quality materials will reduce rejects. A good waste reduction strategy can reduce the amount of material needing to be recycled while increasing profitability and economy for the builder and the customer and reducing the demand for landfill volume.

Recycling of construction waste requires on-site separation. Initially, this requires some extra effort and training of construction personnel, but once separation habits are established, on-site separation can be done at little or no additional cost.

Other components of a waste reuse and recycling plan may include contracts with customers requiring regular pick-ups, use of reusable and standardized construction forms to avoid waste generated by single-use wooden forms, and placing marked bins and staging areas for different materials, with segregation of some materials for on-site reuse.

Technology is quickly developing for recycling of materials into reconstituted building materials and other products. The most widely used technology is the processing of asphalt and concrete debris into road building materials. Wood debris has been processed into a number of products, such as fuel pellets and composite board materials. Recycling of many waste materials requires only some additional effort and coordination with a salvage company or nonprofit organization to reuse them directly without reprocessing.

The potential for reduction, reuse, and recycling of such debris is very high. In a municipal program in the United States, it was found that 59.5% of the incoming debris volume was recyclable. Doing so would extend the life of their landfill approximately 4 years and generate $1.5 million in revenue, sufficient to fund the cost of establishing an on-site construction and demolition waste-recycling center. Careful planning and effective management programs may achieve even higher levels of reduction, reuse, and recycling.

Any change in the present waste of such debris will benefit not only the profitability of the builder but also the municipality, which avoids the need for investment in additional landfill volume, and the global resource base, which is depleted by that much less materials.

Sources: Sustainable Sources. 2006, August. *A Sourcebook for Green and Sustainable Building.* Available: http://www.greenbuilder.com/sourcebook/ConstructionWaste.html

Shoou-Yuh Chang, and Rebecca Cramer. 2003. The Potential For Reduction of Landfill Waste by Recycling and Mining of Construction and Demolition Waste at the White Street Landfill, Greensboro, North Carolina. *Journal of Waste Technology and Management* 29(1). February.

enhancing product life through design strategies. Designers seek to optimize the following product qualities:

- durable and difficult to damage;
- modular;
- multifunctional;
- subcomponents standardized, self-repairing, or easy to repair;
- easy to upgrade;
- components can be reused in new systems; and
- units or systems can be easily reconditioned and remanufactured.

These design strategies are already part of the DfE toolkit. They can significantly cut demand on material and energy resources and reducing pollution from manufacturing. Product-life extension is highlighted in recent practices in the design of new buildings (Box 9.6). A huge volume of high quality structural material becomes landfill waste, or is at best recycled (in the case of steel), during building demolition. To increase the ability to directly reuse building materials, buildings can be designed to make deconstruction an economical alternative to demolition. By providing standard design and detailing approaches, which make deconstruction more feasible, the market will be able to drive the move from demolition to deconstruction. To facilitate this, standards will need to be developed for structural members (e.g., structural steel beams, precast concrete planks, and heavy timbers), which are readily available in many markets. However, with current standards, it is difficult for an engineer to specify reuse without perceived exposure to increased liability.[274]

As a company moves from maximizing sales of material products to the delivery of customer satisfaction, its long-term source of competitive advantage will become the ability to provide the needed service. This idea is the basis of the service economy (also known as the functional economy).

Under a service economy, new ways of dealing with products at the end of their useful lives are related to increasing sales of services rather than products. Revenues could come from leasing of equipment with long life, continuing maintenance and service, major upgrading of systems, parts and supplies, service provider training, and licensing. Or the company might simplify the transaction by offering one, use-based fee.

However, it should be noted that leasing is not a guarantee of eco-efficiency. For instance, dealers of automobiles may still sell older vehicles to the poor and the cycle of deterioration may only be delayed, not ended. Some car hire companies in Australia compete on price with "rent-a-bomb" vehicles, which involves reusing secondhand cars that are well past their prime. This demonstrates the need to combine market-based approaches with effective regulation.

Implemented together, product-life extension and the service economy would help complement recycling by slowing the rapid unsustainable flow of materials and goods through the global, national, and local economies. By increasing the productivity per unit of resource, they could help make very large reductions in materials and energy use needed to satisfy growing consumer needs.[275]

Industrial Metabolism[276]

Industrial metabolism is a method used in the field of industrial ecology (IE), discussed in Chapter 1, to analyze resource flows through a given system and assess relative environmental impacts and critical points for intervention. Based on engineering's mass balance analysis, it traces materials, water, and energy flows from initial extraction of resources through industrial and consumer systems to the final disposal of wastes.[277] This includes inputs into a socioeconomic system, internal flows within a system, flows between different socioeconomic systems, and outputs to the environment (Figure 9.1). It may be applied at the scale of a production line, factory, region, watershed, or even a nation. A few companies have conducted environmental audits based on this method. Regional application gives valuable insight into the sustainability of industry in natural units such as watersheds or atmospheric basins. Mapping sources, processes of transformation, and sinks in a region offers a systemic basis for public and corporate action.

Industrial metabolism analysis highlights the dramatic difference between natural and industrial metabolic processes: in natural systems materials flow in closed loops with near universal recycling. Industrial systems are often very dissipative, leading to materials concentrations too low to provide value but high enough to pollute. Dissipative use is where materials are degraded, dispersed, and lost in the course of usage. Any release to the environment in dissipative form (i.e., too diluted or chemically locked up to be of economic value) is unsustainable, because it moves material "out of reach" of the industrial cycles that depend on it.[278]

Below are some guidelines for improving the metabolic pathways of industrial processes and materials:

274 American Society of Civil Engineers. 2005, 3 June. *Report on Forum on Technical Opportunities for Sustainable Infrastructure*. Available: http://www.asce.org/files/pdf/instfound/june05report.pdf

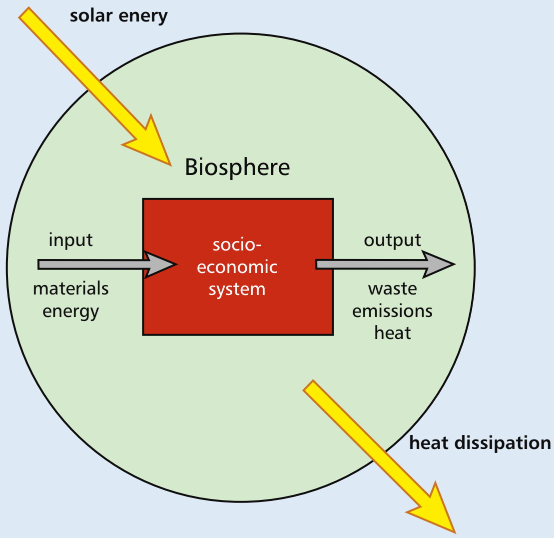
275 Indigo Development. *Industrial Ecology Methods and Tools for Analysis and Design*. Available: http://www.indigodev.com/Tools.html

276 Main source of the next three sections: Lowe, Ernest, John Warren, and Stephen Moran. 1997. *Discovering Industrial Ecology: An Executive Briefing and Sourcebook*. Cleveland, Ohio: Battelle Press.

277 Footnote 275.

278 Ibid.

Figure 9.1: Flow of Materials and Energy



Source: Weisz, Helga, and Heinz Schandl. 2005. *Material Flow Analysis: A Comparison Between Industrialized and Developing Economies.* Open lecture at Universitat Autònoma Barcelona. 26 April. Available: http://www.iff.ac.at/socec/backdoor/sose05-barcelona-mssm/Open_lecture_MFA.pdf

- Reduce dissipative uses of materials through change in product or process design, enhancement of reuse, and recycling.
- Change product design to eliminate toxic materials from being dissipated into the environment as a factor of use.
- Reduce the number of steps in processes to achieve greater energy and resource efficiencies.
- Create on-site, on-demand production of toxic materials.
- Emulate biological metabolism in temperature and pressure and in cyclic processes.
- Improve overall system efficiencies as a cooperative effort between suppliers and customers.

Dynamic Input-Output Models

Faye Duchin, Director of New York University's Institute of Economic Analysis, created "what if" tools on the foundation of industrial metabolism and structural economics. These dynamic input-output models enable business and policy decision makers to perceive the broad business, economic, and environmental implications of systemic technical change. They can be applied to a regional or national economy or specific issues in it.

Input-output models add environmental resource accounts to economic information about the 100+ industrial sectors found in standard national input-output tables. By incorporating a time dimension, Duchin created a means of analyzing the total impacts of alternative scenarios of industrial change. How would the changes affect the environment, businesses in the target industry, and their major suppliers and customers?

Duchin's work provides "an analytic framework for considering the economic implications of complex webs of technical changes... Dynamic input-output models are used to develop a set of possible solutions rather than a single optimal one... . . (making it) possible to experiment with changes in input structures that might reduce water usage in production, for instance, or recover products of economic value… A more complex set of results, involving economic and environmental trade-offs, can be evaluated." Duchin has applied input-output modeling to issues of household consumption, an important first in IE. Most industrial ecologists focus on manufacturing.[279] An application to transportation is given in Box 9.7 (see page 158).

Industrial Symbiosis and By-Product Exchange

The concept of industrial symbiosis, a key field of study and practice of industrial ecology, is based on this process of exchange and collaboration between or among firms, where one facility's waste (energy, water, or materials) becomes another facility's feedstock. Inherent to industrial symbiosis is a cooperative approach to competitive advantage among traditionally unrelated firms. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity.[280]

A by-product exchange is especially useful when managers in a plant reach the limits of cleaner production and still have major unusable wastes. The concept of industrial symbiosis broadens the mission of such a network to sharing other resources, as well as by-products, especially energy, water, and a wide range of services (Box 9.8). For instance, in

279 Ibid.

280 Chertow, M. R. 2000. Industrial Symbiosis: Literature and Taxonomy. *Annual Review of Energy and Environment*. 25:313-337.

Box 9.7: Applying Input-Output Modeling to Transportation

From the Viewpoint of an Automobile Manufacturer

An automobile manufacturer might choose to study the impact on the environment and its own future of possible socio/technological changes such as:

- innovations in engine design resulting from much higher standards for emissions and fuel efficiency,
- systemic redesign of small vehicles as proposed by Amory Lovins,
- increase in the United States' fuel prices to the global average, and
- dramatic increase in short- to mid-distance rail transport and a resulting increase in demand for rolling stock and feeder motor vehicles.

In the input-output study, the auto manufacturer could build alternative scenarios, such as:

- remaining focused on traditional motor vehicle transport through technological innovation needed to meet the regulatory and economic changes;
- developing and marketing lines of alternative vehicles (electric, hybrid-electric, etc.); and
- possible diversification into railcar production through acquisition of a current manufacturer and retooling some of the company's auto parts plants.

Researchers would then go through these steps:

1. Create conceptual models to develop the most useful research questions and to guide next steps.
2. Build a database of relevant data in a form the dynamic input-output model can use:
   - o national accounts with industries selected for the study (if working in a model of the national economy);
   - o environmental accounts reflecting resources and sinks (as well as wastes and emissions) needed to analyze the environmental impact of the technological changes in question;
   - o the company's financial information, especially capital stocks, investments, etc.;
   - o data on capacity utilization and costs, stocks, and flows for energy and materials; and
   - o information on the technologies being evaluated, including projections of technical data for the future.
3. Use existing strategic and technology innovation plans to develop detailed scenarios about alternative future paths.
4. Evaluate each scenario from economic and environmental perspectives using the dynamic input-output model.

The final products for the manufacturer would be a set of scenarios with assessment of the impact of each possible course on its own economic interests and its impact on the environment. It would have a rationale to guide policy and public relations work around its decision. The modeling tool developed for transportation would continue to be useful for evaluation of new strategies as other environmental, technical, and social changes emerge.

From the Viewpoint of Government Ministries

The transportation and economic development ministries of a developing economy might use input-output modeling to evaluate alternative scenarios for creation of a transportation infrastructure and industry. Scenarios explored might include:

- auto-and-truck-based highway system,
- rail-based, intermodal system, and
- moderation of need for travel through application of information technologies.

Some key elements in the model are:

- vehicle efficiency and fuel use;
- emission characteristics and air pollution;
- demands on energy and material resources;
- economic and environmental implications of new roads, rail lines, telecommunications, and other infrastructure;
- congestion and travel times;
- choice among material processing technologies and the associated demand for material and energy resources;
- labor requirements and the capacity of the educational system; and
- information system requirements.

For instance, the leadership of the People's Republic of China is presently projecting an industrial development strategy based on automobile and truck manufacturing and infrastructure. An input-output study as outlined here could open an effective process for exploring alternative strategies.

Source: Lowe, Ernest, John Warren, and Stephen Moran. 1997. *Discovering Industrial Ecology: An Executive Briefing and Sourcebook*. Cleveland, OH: Battelle Press.

Box 9.8: Industrial Symbiosis in Gujarat

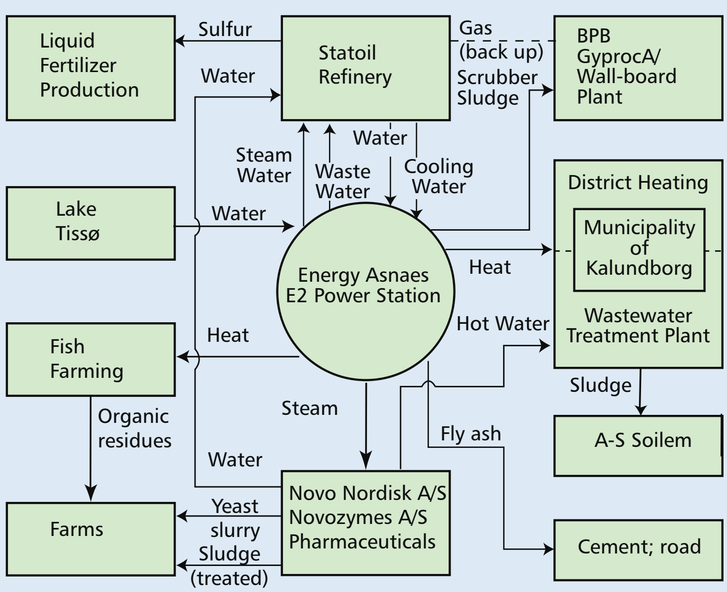
The Naroda Industrial Estate in Ahmedabad, Gujarat, which encompasses 30 square kilometers, includes approximately 700 companies from a diverse set of industries, such as bulk chemicals, pharmaceuticals, dyes, textiles, and food processing. The Naroda Industrial Association partnered with researchers from the University of Kaiserslautern, Germany, to identify potential inter-firm partnerships. One of these opportunities involved collecting spent sulfuric acid, a by-product by several different chemical companies, to produce ferrous sulfate, which has application in textiles, agriculture, and water purification. This production could take place at another company in the estate that had previously been forced to close, but which already owned much of the necessary production technology, drastically reducing the initial capital cost of the project. As a result of the project, chemical companies reduced costs associated with disposal by 50%, local buyers benefited from decreased production costs, and there were unquantified economic benefits to the region from the saving of landfill space and the reduction of environmental risk.

Source: Wilder, Martin Z. 2003. *Economic Growth, Environment and Development*. New Delhi: Manak Publications.

Kalundborg, Denmark, the primary partners—an oil refinery, power station, gypsum board facility, and a pharmaceutical company—share groundwater, surface water, wastewater, steam, and fuel, and also exchange a variety of by-products that become feedstocks in other processes (Figure 9.2). High levels of resource and economic efficiency have been achieved, which has led to many other less tangible benefits involving personnel, equipment, and information sharing.

An interesting debate is the relative extent to which industrial symbiosis emerges from the bottom-up among firms that find it mutually advantageous to make various exchanges or comes top-down through planning processes. Both processes are being used in Asia. As an example of a top-down approach, Japan has designated many ecotown projects, where industrial partners in a city are pursuing waste and material reuse across firms (page 126). One useful mechanism to initiate and expand intercompany collaboration is a coordinating council. In the PRC, "waste minimization clubs" have sprung up in the very large industrial areas of Tianjin and Nanjing.

Figure 9.2: Industrial Symbiosis in Kalundborg, Denmark



Chapter 10. Participating in Regional and International Initiatives

Many of the efforts in Asia to increase the efficiency of resource use will be strengthened through regional cooperation and integration. This is especially true to address problems associated with hazardous wastes and transboundary pollutants.

This chapter looks at two important elements of regional cooperation related to resource efficiency—information sharing and capacity building, and promoting the safe trade of secondary materials.

Regional Information Sharing and Capacity Building

Information sharing is critical at the regional and international levels. Information sharing can help harmonize policies and reduce the gap between countries in recycling-related institutional structure and recycling and management capacity. Sharing the experience of developed countries with proper recycling and waste management mechanisms can be useful for such capacity development to help improve systems for collection, transportation, treatment, storage, recovery, and disposal.

Information sharing in the region can be accelerated through

- information standardization on products regarding their recyclability and proper management;
- risk and proper management information on regulated and controlled substances and materials;
- national policies and frameworks for recycling and waste management;
- national regulations and standards;
- information on relevant institutions;
- incentive mechanisms, such as ecolabeling, taxation, or certification or certification and awards for good practices of reliable recyclers;
- statistics on traded amounts of secondary materials; and
- records of inappropriate incidents and relevant importers and dealers.[281]

Information harmonization is likely to have some important benefits. First, sharing harmonized information on institutions and systems of domestic recycling would help producers find and use proper recycling facilities more easily. Harmonizing and sharing information on products and components would also help facilitate a better understanding of the recycling potential of products, as well as proper recycling methods and technologies. One useful source is the 3R Knowledge Hub (Box 10.1).

Box 10.1: The 3R Knowledge Hub

As part of regional efforts to promote the 3R Initiative, the 3R Knowledge Hub was jointly established by the United Nations Environment Programme and the Asian Institute of Technology in Bangkok, Thailand, in 2006, with support from the Asian Development Bank. The hub aims to collect, create, and disseminate knowledge relevant to the 3Rs, specifically in municipal, medical, and e-waste solid waste management.

The hub will also help develop broad guidelines and training programs and will encourage nations to develop national integrated policy frameworks and national action plans to promote resource efficiency. It will seek to promote to industry best practices that regulatory agencies endorse and, where possible, to work closely with trade and industry associations. Development of knowledge is under way with collaboration between several international and government partners.

3RKH Reduce, Reuse, Recycle

Source: www.3rkh.net

[281] UNESCAP and IGES. 2006. Discussion Points for the Internationally-Harmonized EPR Systems. Asia 3R Conference. 30 October–1 November. Tokyo.

Box 10.2: The International Expanded Polystyrene Alliance

Expanded polystyrene (EPS) is widely used for packaging, construction, and insulations. In November 1992, an international agreement to promote EPS recycling was made between Austria, Germany, Japan, and US. This was very unique agreement to promote international cooperation among the packaging industries globally.

The agreement made three major commitments. First, it guaranteed the same level of access for imported EPS packaging as domestic EPS packaging to national recycling mechanisms. Second, the countries committed to promote national recycling mechanisms. Third, countries committed to establishing a worldwide network to exchange information on EPS recycling. The number of formal commitments to the agreement rapidly increased to more than 30 countries.

In 2000, three major EPS organizations—AFPR (North America), AMEPS (Asia Pacific) and EUMEPS (Europe)—established the International EPS Alliance (INEPSA) to exchange information about EPS environmental and solid waste management programs between packaging experts. In 2002, ASAPEX (South America) joined. Since then, more than 30 countries associations have signed INEPSA.

In addition, as of 2007, 14 countries in the Asia-Pacific region have joined AMEPS. They hold general meetings regularly and exchange information and build awareness on EPS recycling. In 2006, EPS recycling ratio among AMEPS member nations reached 67%. This is remarkably higher than that in the North America and European Union. According to AMEPS, recycling rates in North America in the 2000s were around 25% and those of the European Union were around 30–40%.

AFPR = Alliance of Foam Packaging Recyclers, AMEPS = Asian Manufacturers of Expanded Polystyrene, ASAPEX = Associación Sur Americana Polistireno Expandido, EUMEPS = European Manufacturers of Expanded Polystyrene.

Source: Personal communication with the Japan Expanded Polystyrene Recycling Association (JEPSRA), 3 September 2007.

It could also help the region respond to integrated product policy initiatives in the EU. These include end-of-life vehicles regulations, RoHS (in electrical and electronic equipment), WEEE directives, and REACH regulation.

In response to these integrated product policy initiatives, manufacturers in Asia will confront increased responsibilities, such as safety evaluation of products, avoiding the use of hazardous substances in products, and registering used chemicals. Thus, it will become increasingly important to make information of the degree of hazard and recycling potential of the products available to relevant stakeholders along the product life cycle, such as suppliers of components, product manufactures, and waste management service providers. In some cases, international industry alliances, such as the International Expanded Polystyrene Alliance (Box 10.2), could be used to expand recycling markets through coordinated action.

Promoting Safe Trade of Secondary Materials

The expanding trade in secondary materials offers both opportunities and threats in terms of Asia's environment and its sustainable development prospects. Depending on how it is conducted, trade can either complement waste minimization in the region or significantly increase environmental pollution and human health risks.

Secondary materials constitute one of the most important material flows worldwide.[282] One estimate suggests that the size of the global secondary materials markets in 2004 was 600 Mt, exceeding $100 billion.[283] Some materials are part of regional markets (compost, wood); national markets (glass); or international markets (paper, plastics, ferrous and nonferrous metals, and textiles). Secondhand goods, such as used buses or automobiles, construction equipment, home appliances, and computers are also internationally traded. Most of them are exported from developed countries to developing countries. Even ships are being exported to developing countries to be recycled (Box 10.3).

[282] Secondary materials are defined as materials or goods that have been manufactured and used at least once and are to be used again. The term is often used interchangeably with recyclable resources and materials and sometimes includes secondhand goods. However, it should be noted that, in reality, the definition and distinction of secondary materials, recyclable resources and materials, and secondhand goods, as well as waste, is a very complex policy-relevant issue itself.

[283] Lacoste, Elisabeth, and Philippe Chalmin. 2006. *From Waste to Resource: An Abstract of "2006 World Waste Survey*." Cyclope. Commissioned by Veolia Environmental Services. Paris.

Box 10.3: Shipbreaking in Developing Countries

Formerly, shipbreaking was concentrated in developed countries, but now it mainly operates in developing countries due largely to their low labor costs and, in some cases, less stringent environmental and safety standards. According to Greenpeace, Bangladesh People's Republic of China, India, Pakistan, and Turkey account for 90% global shipbreaking.

Shipbreaking is a form of recycling, mainly to recover iron scraps. About 95% of ship components are iron. However, because hazardous substances, including polychlorinated biphenyls (PCBs) and asbestos, have been used in vessels, shipbreaking for material recovery causes very heavy pollution in these countries. In the process of recovering iron and copper scrap and other materials from ships, hazardous substances often move into the environment and can create serious health problems for workers and their communities. However, for workers who often come from the poorest regions/districts of low-income countries, it is a source of jobs and resources. Therefore, there is a heated debate about the benefits and risks currently presented by the ship dismantling industry.

Detailed information is given in the Basel Convention's website, on Ship Dismantling: http://www.basel.int/ships/index.html

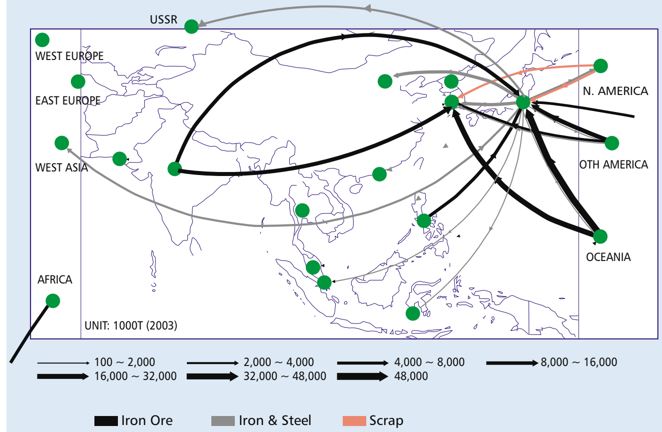
Source: Greenpeace Shipbreaking Site. Available: http://www.greenpeaceweb.org/shipbreak/whatis.asp

Expanding trade of secondary materials can be attributed to a number of factors, including (i) the increased recovery of recyclable waste commodities in developed countries in line with the development of associated legislation; (ii) the shift of various production bases from developed countries to Asian countries, especially the PRC; (iii) the inability of developed countries to consume domestically all the recyclable resources they generate; and (iv) the increasing demand for resources in Asian countries that cannot be met by domestically-generated volumes of recyclable waste.[284]

Secondary Material Trade Flows

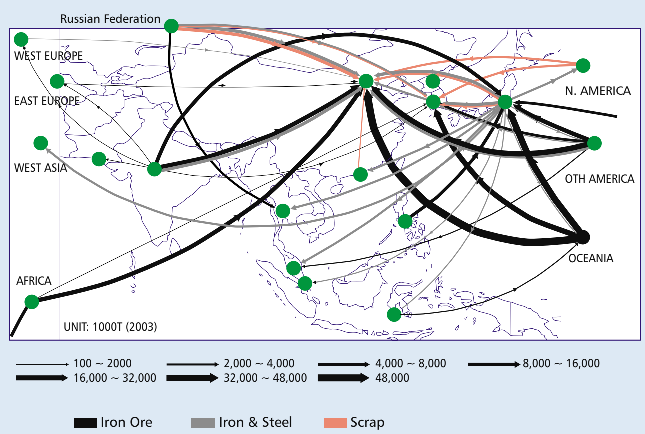
A recent study by the Japanese National Institute for Environmental Studies looked at the material flows of ferrous materials in Asia and discovered a complicated global trade system centered on PRC, India, Japan, and Republic of Korea.[285] The study revealed that demand for recyclable wastes shipped from developed countries to developing countries (Figures 10.1 and 10.2) has increased sharply. Exports from EU, Japan, and US have been

Figure 10.1: International Trade of Iron Ore, Steel, and Scrap Iron in Asia (1983)



USSR = Union of Soviet Socialist Republics.

Figure 10.2: International Trade of Iron Ore, Steel, and Scrap Iron in Asia (2003)



Source: Moriguichi, Yuichi, and Seiji Hashimoto. 2006. *Material Flow Databook –Third Edition. World Resource Flows around Japan.* Center for Global Environmental Research of NIES. Available: www-cger.nies.go.jp/publication/D040/cd/Flow/pdf/Asia/2003/iron-03.ctl.pdf

284 Kojima, Michikazu. 2005. Current Trade Flows in Recyclable Resources within Asia & Related Issues. *IDE Spot Survey* No.29. Chiba: Institute of Developing Economics. May.

285 Moriguchi, Yuichi, and Seiji Hashimoto. 2006. *Material Flow Databook (Third Edition), World Resource Flows around Japan*. Tsukuba: Center for Global Environmental Research, National Institute for Environmental Studies. Available: http://www-cger.nies.go.jp/publication/D040/cd/Flow/pdf/Asia/2003/iron-03.ctl.pdf

Table 10.1: Gross and Net Exports of Recyclable Wastes by Major Asian Nations, 2005 (Difference between gross exports and gross imports)

Waste	PRC		India		Indonesia		Japan		Republic of Korea		Malaysia		Philippines		Thailand	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
Plastics	45	(4,912)	11	(85)	29	24	1,058	1,055	235	210	112	37	80	72	130	129
Paper	0.1	(17,032)	3	(1,653)	16	(1,942)	3,710	3,633	46	(1,304	0.8	(165)	1	(286)	15	(931)
Iron	2	(10,134)	5	(4,903)	70	(1,132)	7,576	7,893	207	(6,607)	227	3,224	972	958	173	(1,510)
Copper	8	(4,813)	4	(146)	32	18	424	321	161	(45)	75	(161)	15	11	283	278
Aluminum	1	(1,989)	0.8	(216)	15	(8)	96	(13)	11	(287)	14	no data	13	13	21	(10)
Lead	.0	0	0.1	(32)	0.0	0	9	9	0	(2)	0.4	0	0.8	1	0.2	0

PRC = People's Republic of China.
Source: Kojima, Michikazu. 2005. Current Trade Flows in Recyclable Resources within Asia & Related Issues. *IDE Spot Survey* No.29. Chiba, Japan: Institute of Developing Economics.

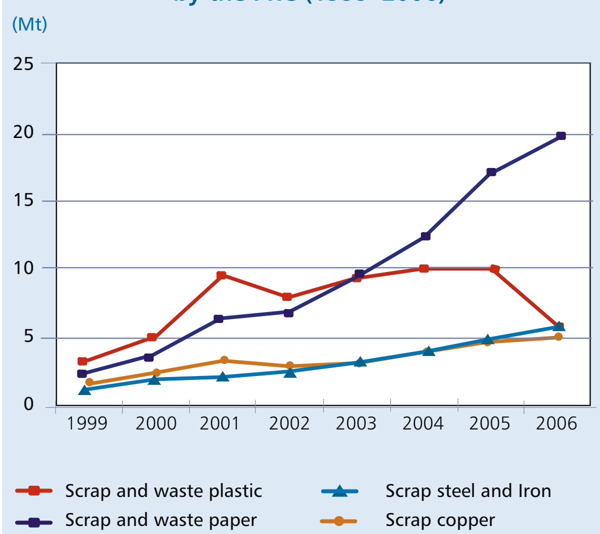
growing.[286] The region is also observing increasing trade in secondary materials among developing countries. For instance, various secondary materials from Kathmandu, Nepal, are collected, sorted, and exported to India. Likewise, surplus materials from Kolkata, India, are exported to Bangladesh.[287]

Table 10.1 shows some specific trends:

- Japan, with the exclusion of scrap aluminum, is a net exporter of secondary materials.
- The Republic of Korea is a net importer, with the exclusion of scrap plastics.
- India is a net importer of all kinds of secondary materials.
- All the countries of Southeast Asia are net importers of waste paper (due to increasingly short supplies of raw materials used for paper manufacture, associated with dwindling forest resources).
- The PRC is one of the biggest net importers of all kinds of secondary materials.

The PRC's imports of recyclable materials deserve special mention. These are growing especially rapidly, fueled by high demand for resources due to rapid economic growth (Figure 10.3). For instance, imports of scrap copper far exceed imports of crude copper and copper ore (Figure 10.4).

Figure 10.3: Import of Recyclable Resources by the PRC (1999–2006)

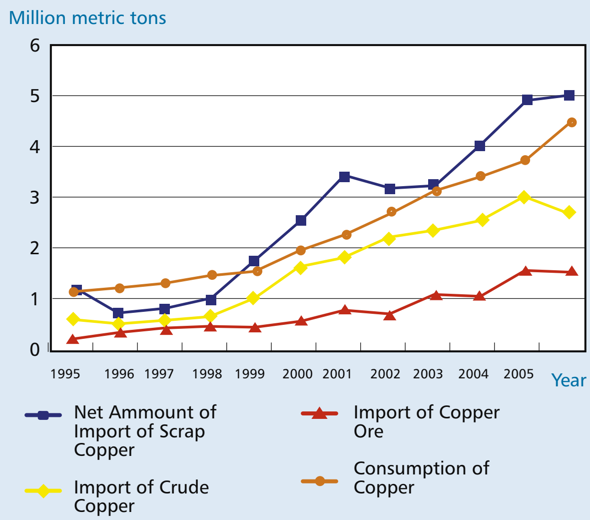


Mt = million metric tons, PRC = People's Republic of China.
Source: Compiled by Michikazu Kojima based on China Customs Statistics.

286 Ibid.

287 UNEP. International Environmental Technology Centre. 2002, March. *International Source Book on Environmentally Sound Technologies (ESTs) for Municipal Solid Waste Management (MSWM).* Available: http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/RO/asia/topic_a.asp

Figure 10.4: The PRC's Increasing Demand for Copper



Mt = million metric tons, PRC = People's Republic of China.

Compiled by the Institute of Global Environmental Strategies based on the following sources:

1. Osame, A. 2003. Reflection of China's Non-Ferrous Industry in 2002, Influence of SARS and Future Perspective of Copper Supply and Demand. *Kinzoku Shigen Jouhou (Metal Resource Report)* 33(4). Japan Oil, Gas and Metals National Corporation (JOGMEC).
2. Osame, A. 2005. Reflection of China's Non-Ferrous Industry in 2003. *Kinzoku Shigen Jouhou (Metal Resource Report)* 34(5). JOGMEC. Available: http://www.jogmec.go.jp/mric_web/kogyojoho/2005-01/MRv34n5-02.pdf
3. Sawada, K. 2006. *Trend of Copper Consumption in China and Copper Industry in Mongolia and Kazakhstan*. JOGMEC. Available: http://www.jogmec.go.jp/mric_web/koenkai/060622/breifing_060622_1.pdf
4. World Trade Atlas Database.

Notes: Import of Scrap Copper is based on H.S.Code 7404; Import of Crude Copper is based on H.S.Code 7402; Consumption of Copper is based on Sawada (2006) and Osame (2003, 2005).

Opportunities and Threats of the Trade

In principle, with strict and proper implementation of appropriate safeguards, along with measures to properly treat and dispose of waste domestically, the trade of secondary materials offers many benefits. For importing countries, secondary materials can be used as cheap sources of materials for production, thus lessening consumption of primary virgin material and avoiding environmental pollution associated with extraction, transportation, and refining of primary resources. Trade of secondary materials can also help narrow the demand-supply gap of secondary materials that currently exist in many domestic markets and open up international recycling markets.

In addition, for countries that lack their own facilities for proper disposal of hard-to-manage wastes, shipping waste to other countries may be the most viable solution. This is the case for the Pacific Islands, which are struggling to manage metal scrap from old vehicles, as described in Box 2.2 on page 22.

Despite these positive aspects, the transboundary movement of secondary materials often results in transferring pollution and waste to low-income countries, where environmental and safety standards are typically low and labor is cheap. Through this transboundary movement, developing countries are forced to bear the burden of final waste disposal for developed countries, which are not fully internalizing the total costs of recycling and disposal of products.

Particularly troubling is the fact that hazardous materials are part of this transboundary movement. Tons of hazardous waste vanish every year into illicit dumps in the region. This waste includes unrecoverable wastes, such as toxic incinerator ash, industrial sludge, contaminated medical equipment, and persistent organic pollutants.

It also includes hazardous waste contained in secondhand goods—older finished consumer products that are partly recyclable—including electrical and electronic equipment and used vehicles. While secondhand goods offer less expensive options for producers and consumers, the useful life of secondhand goods is usually shorter than for newly manufactured goods and they usually are less energy efficient and much more polluting. For instance, a study shows that 700 tons of ozone depleting substances in car air-conditioners was moved to Asian countries from Japan as a result of used car export from Japan.[288] Some countries restrict the import of secondhand goods, not only to limit pollution but also to protect domestic manufacturers.

One of the biggest environmental concerns in the region is the importation of discarded electronics, or e-waste, which has been called the "dirty little secret of the high tech revolution." Much of the e-waste collected for recycling in developed countries is not recycled domestically, but is instead placed on container ships, many bound for developing countries in Asia. Asian countries accept tens of millions of pieces of discarded electronics equipment

288 Minato, K., A. Funazaki, and S. Kajima. 2004. Estimation in Export of Secondhand Cars and Amount of Environmental Burden. In *Conference Proceedings of the 8th Energy System and Economics Conference*. Japan Society for Energy and Resources. 23–25.

Box 10.4: E-Waste Recycling and Disposal in Developing Asian Countries

The e-waste recycling and disposal operations found in developing countries are extremely polluting and likely to be very damaging to human health. The entire recycling system operates as a trade value chain. Recycling is characterized by a hierarchy of physical dismantlers and metal extractors. The chain starts from the formal sector, where obsolete electronic items are traded from the organized market and passed from one level of dismantler to another level, depending on the item and value of its content, and finally leading to metal extraction.

In many parts of Asia, dismantling and recycling of electronic wastes is frequently carried out in small workshops and industrial units. In these places, "recycling" is a misleading characterization of many disparate practices—de-manufacturing, dismantling, shredding, and burning—that is mostly unregulated and often creates additional hazards. Some of the hazardous recycling processes include extraction of metals, such as copper and gold, using acid treatment and primitive metallurgical processes, while physical processes include recovery of glass by breaking cathode ray tubes. The crude metal extraction process leads to uncontrolled effluent discharges in urban and rural drainage systems, while glass recovery leads to lead and other emissions in the air.

Although valuable materials and components are recycled, much of the less valuable material is simply dumped by the roadside or in landfills or burned in open air. As reported in the report *Exporting Harm: The High-Tech Trashing of Asia*, which documents the harmful effects of the e-waste trade on Asian communities in the People's Republic of China (PRC), India, and Pakistan:

"A tremendous amount of imported e-waste material and process residues are not recycled but simply dumped in open fields, along riverbanks, ponds, wetlands, in rivers, and in irrigation ditches. These materials include leaded CRT glass, burned or acid-reduced circuit boards, mixed, dirty plastics including mylar and videotape, toner cartridges, and considerable material apparently too difficult to separate. Also dumped are residues from recycling operations including ashes from numerous open burning operations, and spent acid baths and sludges."

Source: Kojima Michikazu, JETRO.

The most infamous destination for e-waste is Guiyu in Guangdong, PRC, a city that is almost entirely devoted to receiving e-waste shipped from the United States, Europe, and Japan. In communities throughout Guiyu, poor people, many of them children, can be seen in concrete-block sheds sifting through computers and printers and breaking them into scrap with their bare hands. As rivers and soils in these communities often absorb high amounts of carcinogens and other toxins, people suffer high incidences of birth defects, infant mortality, tuberculosis, and blood diseases, as well as particularly severe respiratory problems.

Source: Basel Action Network and Silicon Valley Toxics Coalition. 2002. *Exporting Harm: The High-Tech Trashing of Asia.* February.

every year. A number of Asian countries are considered to be common destinations for e-waste, including PRC, India, Malaysia, Philippines, Singapore, Sri Lanka, Thailand, and Viet Nam. In these countries, labor is cheap and occupational and environmental protection is generally weak. These countries are also ill-equipped to deal with mountains of discarded electronics and the toxic substances—lead, mercury, cadmium—that they contain (Box 10.4).

Controlling this transboundary movement of hazardous waste is not easy. It is believed that significant amounts of hazardous waste are smuggled without prior notification and consent, and it is relatively easy to dump hazardous waste illegally. Lack of proper disposal and recycling capacity, legal frameworks, and enforcement capacity in developing countries contributes to this problem.

Furthermore, there is an absence of education on the harmful effects of handling toxic materials. In the developed world, toxic materials are labeled and accompanied with safety procedures, but people in poor communities usually handle these materials with their bare hands and without respiratory protection. Most poor communities who handle toxic materials do not realize the threats they are facing, do not know what protective measures to take, and do not have the means to advocate for themselves. Compounding the problem, the medical community has also not been trained to recognize symptoms and deal with the effects.

Box 10.5: Basel Convention: Article 4

General Obligations

1. (a) Parties exercising their right to prohibit the import of hazardous wastes or other wastes for disposal shall inform the other Parties of their decision pursuant to Article 13.

   (b) Parties shall prohibit or shall not permit the export of hazardous wastes and other wastes to the Parties which have prohibited the import of such wastes, when notified pursuant to subparagraph (a) above.

   (c) Parties shall prohibit or shall not permit the export of hazardous wastes and other wastes if the State of import does not consent in writing to the specific import, in the case where that State of import has not prohibited the import of such wastes.

Basel Ban Amendment inserted in new Article 4A:

1. Each Party listed in Annex VII shall prohibit all transboundary movements of hazardous wastes which are destined for operations according to Annex IV A, to States not listed in Annex VII.
2. Each Party listed in Annex VII shall phase out by 31 December 1997, and prohibit as of that date, all transboundary movements of hazardous wastes under Article 1(1)(a) of the Convention which are destined for operations according to Annex IV B to States not listed in Annex VII. Such transboundary movement shall not be prohibited unless the wastes in question are characterised as hazardous under the Convention. …'"

The status of the amendment ratifications can be found on the Basel Secretariat's web page. http://www.basel.int/ratif/ban-alpha.htm

The international community is increasingly acknowledging this problem and is endeavoring to fight it. Efforts to control the movement of hazardous waste are centered around the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, which was adopted in 1989 and entered into force on 5 May 1992. The convention calls for all countries of the world to become self-sufficient in waste management and to minimize all transboundary movements of hazardous wastes. The convention also requires exporters of hazardous wastes to give prior notification to the government of the importer country and to obtain their approval.

After the initial adoption of the convention, some least developed countries and environmental organizations argued that it did not go far enough and pushed for a total ban on the shipment of all hazardous waste to non-OECD countries. After long and intensive debates at the 1995 Basel conference, a decision was made to adopt the Basel Ban Amendment to the Basel Convention. The amendment, which is yet to come into force, prohibits the export of hazardous waste from a list of developed (mostly OECD) countries to developing countries. The Basel Ban Amendment applies to export for any reason (Box 10.5).

As of late-2005, 63 nations had ratified the Basel Ban Amendment (62 are required for it to enter into force), but it not yet in force due largely to opposition by a number of countries. The EU fully implemented the Basel Ban in its Waste Shipment Regulation, making it legally binding in all EU member states.

Although the establishment of the Basel Convention represented the start of international efforts to control transboundary movements of hazardous wastes, illegal traffic is still being observed. Like most other multilateral environmental agreements, the Basel Convention is stifled by inadequate implementing legislation, underdeveloped legal systems, and a lack of enforcement among its members. However, even where legislation exists, illegal shipments still occur. For instance, a newspaper reported that exporters of e-waste to the PRC can avoid detection by routing container ships through Hong Kong, China; Philippines; and Taipei,China, and then transshipping them to smaller ports in mainland PRC, where customs officials are willing to look the other way in exchange for a share of the spoils.[289]

[289] Goodman, Peter. 2003. China Serves As Dump Site For *Computers: Unsafe Recycling Practice Grows Despite Import Ban*. Washington Post Foreign Service. 24 February. Available: http://www.washingtonpost.com/ac2/wp-dyn/A56653-2003Feb24?language=printer

A number of recent illegal trafficking incidents have come to light in Asia. For instance, in April 2004, a shipment from Japan to Tsingdao, PRC, was found on inspection by a PRC officer to contain large quantities of contaminated plastics, covered by a small amount of clean and crushed plastic to disguise the shipment. This incident caused the PRC Government to impose a temporary ban on waste plastic imports from Japan. An incident of unauthorized exporting of industrial waste from Taipei,China to Malaysia was also revealed in 2004.[290]

In one infamous incident, the now-defunct Japanese company Nisso was caught by the Philippine police trying to dump 2,100 tons of infectious medical waste in the Philippines in December 1999. The shipment of used needles, syringes, diapers, and other discarded hospital products was disguised as recyclable scrap paper. In response, the Government of Japan spent a large sum to transfer the waste back to Japan for proper treatment.[291] Following the incident, Japan also strengthened its manifest system for tracking shipments and implemented the "revision of waste management law" to clarify polluters' responsibilities.

In addition to blatantly illegal shipments, another issue is that a certain portion of trade in goods that are classified as secondhand goods are actually near end-of-life products. In many cases, only certain parts are extracted from the goods, and the rest is discarded, often through illegal dumping. This is particularly true in the case of used electrical equipment, such as mobile phones and computers. Because the Basel Convention does not regulate international trade of secondhand goods, prior notification and consent procedures are not required for these goods. In fact, there is no internationally standardized definition of secondhand goods, although ISO has discussed a new international standard guiding the cross-border trade of secondhand products.[292] It is also currently difficult to trace movement of secondary materials to ensure that they are treated at proper recycling facilities.

This is not a simple issue, because there is a market-based driving force for refurbishing or extracting resources from near end-of-life products. For instance, although PC contain hazardous substances, there is a clear economic incentive for refurbishing used PCs and disassembling obsolete PCs, monitors, and circuit boards and then recovering nonferrous metals, such as gold and copper. Many local people engaged in small-scale informal recycling consider this a vital employment opportunity. In the national capital region of Delhi, India, the yearly sales turnover of e-waste recycling during 2002–2003 was $5 million, with 941,274 yearly person hours spent on recycling and 10–20% profit margin.[293]

One recent development that is causing some concern in the region is Japan's efforts to negotiate bilateral agreements as a way to liberalize and promote trade that environmentalists and civil groups claim will circumvent the Basel Convention. The Basel Action Network, an organization that opposes trade in toxic wastes, products, and technologies, recently issued a Basel Non-Compliance Notification Report on the issue. The report charges that Japan is openly in noncompliance with the Basel Convention through the development of contradictory bilateral agreements.[294]

The Japan-Philippine Environmental Partnership Agreement (Box 10.6) is the latest of a series of recent bilateral agreements that Japan is negotiating throughout the Pacific Rim countries. In the first quarter of 2007, Japan also finished negotiations with Thailand on the Japan-Thailand Economic Partnership Agreement. In both cases, a letter was exchanged between the countries stipulating that the trade pact will not overrule the Basel Convention. Japan is now in negotiations with Indonesia and India for their respective agreements. Civil society groups in both India and Indonesia are taking

290 Kojima, Michikazu. 2005. Current Trade Flows in Recyclable Resources within Asia & Related Issues. *IDE Spot Survey* No. 29. Chiba: Institute of Developing Economics. May.

291 Schmidt, Charles W. 2004, Feb. Environmental Crimes: Profiting at the Earth's Expense. *Environmental Health Perspectives* 112(2). Available: http://www.ehponline.org/members/2004/112-2/focus.html

292 Resolutions of 25th meeting of Committee on Consumer Policy of the International Organization for Standardization, 2003. Bangkok, 10–11 September. Available: http://www.jisc.go.jp/policy/pdf/25th_meeting,_10-11_September_2003.pdf

293 Jain, Amit. 2006. Perspective of Electronic Waste Management in South Asia: Current Status, Issues and Application of 3Rs. Paper for Promoting Reduce, Reuse and Recycle in South Asia; Synthesis Report of 3R South Asia Expert Workshop. ADB, IGES, and UNEP. Kathmandu, Nepal 30 August–1 September.

294 Basel Action Network. 2007, 12 Mar. *Basel Non-Compliance Notification Report*. Available: http://www.ban.org/Library/Japan_JPEPA_BNN2007_1.Final.pdf

Box 10.6: The Japan-Philippines Economic Partnership Agreement

In September 2006, Japan and the Philippines signed a bilateral trade agreement known as the Japan-Philippine Economic Partnership Agreement (JPEPA). In the JPEPA agreement, a legally binding instrument, trade covers articles "which can no longer perform their original purpose…nor are capable of being restored or repaired and which are fit only for disposal or for the recovery of parts or raw materials."

Environmentalists are fearful that reducing tariffs to zero will offer a blanket invitation to make the Philippines the dumping ground for Japanese waste, especially hazardous and toxic waste. They also stress that the JPEPA provisions violate and contradict both Philippine laws, such as the Toxic Substance and Hazardous and Nuclear Waste Act of 1990 and the Clean Air Act of 1999, the latter because JPEPA includes toxic incinerator ash (The CAA bans incineration partly because of the problems surrounding disposing of incinerator ash).

Proponents of the Agreement downplay these concerns. The Philippines' Department of Environment and Natural Resources claims that JPEPA will not violate Philippine laws because toxic and hazardous waste are banned. A letter from the Minister for Foreign Affairs of Japan to the Secretary of Foreign Affairs in the Philippines contained the following statement:

> "I am pleased to confirm the statement and commitment of Prime Minister Shinzo Abe that Japan would not be exporting toxic wastes to the Philippines, as defined and prohibited under the laws of Japan and the Philippines, in accordance with the Basel Convention, and the understanding that provisions related to this topic in the Japan-Philippines Economic Partnership Agreement (JPEPA) do not prevent the adoption or enforcement of such measures under existing and future national laws, rules and regulations of the Philippines and Japan."

Due to the 2007 midterm elections, the Philippine Senate has not acted on the JPEPA ratification. Environmentalists and nationalist trade advocates are now scrambling to convince the Philippine Senate, the country's treaty ratifying body, to reject JPEPA when it is transmitted to Congress.

Sources: Pabico, Alecks. 2006. *JPEPA to encourage trade in hazardous and toxic waste*. Philippine Center for Investigative Journalism. 25 October. Available: http://www.pcij.org/blog/?p=1264; http://www.mofa.go.jp/region/asia-paci/philippine/epa0609/letter.pdf

steps to get information from their respective governments.

Policies to Promote Safe Trade of Secondary Materials

In response to these emerging concerns, multilateral and regional efforts must be accelerated to seek coordination and balance between domestic recycling systems and transboundary networks in a way that eliminates associated environment and health risks while realizing the potential benefits of improving resource efficiency in the region as a whole. To accomplish this, a common and clear policy and vision must be developed that is consistent with current international agreements, such as the Basel Convention. The prevention of environmental pollution and health risks must be emphasized as a major precondition to international reuse and recycling. Both exporting and importing countries must strive jointly to prevent the creation of environmental pollution from transboundary movements of secondary materials.

It must be emphasized that exporting countries and exporters must take responsibility in such efforts, especially considering the insufficient capacity of many importing countries in tracking these materials and in treatment technologies. Along with governments, manufacturers and consumers must participate in solving this problem, such as participating in product stewardship programs, life-cycle management, and changing consumption patterns. The problem will never truly be solved unless goods are redesigned and reformulated to facilitate proper dismantling and component separation and to avoid the use of hazardous chemical components at source. Manufacturers must develop and design products that are easy to repair, upgrade and recycle, have longer life spans, and will not expose workers and the environment to hazardous chemicals. Otherwise, they will continue to generate polluting residues and emissions at end-of-life, whether in developed-country landfills or developing-country waste recovery industries.

The problem is complex and a comprehensive solution requires a variety of remedies. Some of the actions that developing countries should consider are discussed below as part of a regional effort to address the problem. In addition to these measures, it is also important that individual countries improve the management of their waste domestically, as described in the section on page 57.

Passing and Enforcing Tougher Laws

Policy makers must strengthen the roles of national and local regulators in eliminating the negative impacts of such trade. Where effective legislation exists, illegal trade can be curbed (but not entirely stopped) if countries are willing to target flagrant violators, increase the use of sanctions and other penalties, encourage compliance through positive incentives, and mandate the use of identifying documents to flag shipments governed by the Basel Convention. Parties to the Basel Convention are also encouraged to participate in the Basel Convention Partnership activities such as on Mobile Phone Partnership Initiative that was adopted in 2002 (http://www.basel.int/industry/mppi.html).

Fortunately, a number of countries are starting to take a tougher line as the social fallout from this harmful trade is becoming more apparent. The PRC has ratified the complete Basel package and in February 2006, adopted guidelines similar to the RoHS in the European Union for phasing out of toxic substances, including mercury, lead, and cadmium, from electronic goods.[295]

Through tougher regulations, some other countries in the region have been able to slow imports of lead scrap, which falls within the scope of the Basel Convention. For instance, in Indonesia and Taipei,China, lower lead imports are clearly a consequence of the introduction of regulations on imports of lead scrap such as waste car batteries. India also tightened its restrictions on lead waste imports in 2000 and import volumes fell, but they have been creeping up again during the past few years.[296]

Tracking Shipments of Secondary Materials

Besides passing tougher regulations, countries need to improve their domestic ability to gather data on and inventory transboundary movements of secondary materials. This includes defining national measures and tools for effective shipment tracking and compliance monitoring for hazardous chemicals. Definitive documentation systems, such as manifests that identify shipments, can help ensure compliance. To help facilitate this, imports and exports of hazardous e-waste should be subject to prior-informed-consent procedure as required under the Basel Convention. In addition, it is extremely important to build the capacity and strengthen the governance of customs agents and other officials.

Some countries in the region have passed laws to allow preshipment inspections, a measure that falls outside the framework of the Basel Convention. Such inspections aim to prevent entry of unrecoverable waste shipped as recyclable waste. For instance, Indonesia requires preshipment inspections of waste paper and scrap metal, used capital goods, and secondhand buses. Imports of recyclable waste (e.g., waste plastics, scrap metal, and waste paper) bound for the PRC are also subject to preshipment inspection. The PRC also introduced an exporter registration system in January 2005, because preshipment inspections alone were failing to stem the flow of illegal traffic.[297]

For proper application of trade measures, exporting countries must cooperate in monitoring efforts. Also, to reduce negative impact and to maximize net benefit, countries should apply stricter domestic environmental standards in addition to a combination of trade measures to control trade of end-of-life products.

In all national efforts, international networks are potentially useful in linking regulatory agencies, law enforcement officials, prosecutors, NGOs, and other stakeholders. These networks can help coordinate law enforcement efforts and strategies, gather information, create acceptable environmental standards, raise awareness about enforcement issues, and assist in developing and implementing legislation more effectively.

An independent international body needs to coordinate these efforts. Toward this objective, UNEP set up the "Green Customs" program, launched in June 2003. This program aims to improve coordinated intelligence gathering and training of customs agents who are saddled with monitoring

295 Boyd, Alan. 2003. IT Revolution's Dirty Secret: E-Waste Exports. *Asia Times Online*. 8 August. Available: http://www.atimes.com/atimes/Asian_Economy/EH08Dk01.html

296 Kojima, Michikazu. 2005. Current Trade Flows in Recyclable Resources within Asia & Related Issues. *IDE Spot Survey* No. 29. Chiba: Institute of Developing Economics. May.

297 Kojima, Michikazu. 2005. Current Trade Flows in Recyclable Resources within Asia & Related Issues. *IDE Spot Survey* No. 29. Chiba: Institute of Developing Economics. May.

Table 10.2: Ratification Status of Basel Convention by ADB Regional Member Countries

Country	Basel Convention	Ban Amendment
Armenia	1999 (a)	
Australia	1992 (a)	
Azerbaijan	2001 (a)	
Bangladesh	1993 (a)	
Bhutan	2002 (a)	
Brunei Darussalam	2002 (a)	2002 (A)
Cambodia	2001 (a)	
China, People's Republic of	1991 (r)	2001 (r)
Cook Islands	2004 (a)	2004 (r)
India	1992	
Indonesia	1993 (a)	2005 (r)
Japan	1993 (a)	
Kazakhstan	2003 (a)	
Kiribati	2000 (a)	
Korea, Republic of	1994 (a)	
Kyrgyz Republic	1996 (a)	
Malaysia	1993 (a)	2001 (r)
Maldives	1992 (a)	
Marshall Islands	2003 (a)	
Micronesia, Federated States of	1995 (a)	
Mongolia	1997 (a)	
Nauru	2001 (a)	
Nepal	1996 (a)	
New Zealand	1994 (r)	
Pakistan	1994 (a)	
Papua New Guinea	1995 (a)	
Philippines	1993 (r)	
Samoa	2002 (a)	
Singapore	1996 (a)	
Sri Lanka	1992 (a)	1999 (r)
Thailand	1997 (r)	
Turkmenistan	1996 (a)	
Uzbekistan	1996 (a)	
Viet Nam	1995 (a)	

(a) = Accession, (A) = Acceptance, (r) = Ratification.

Source: Basel Convention Secretariat. Available: http://www.basel.int shipments falling under multilateral environmental agreements and distinguishing them from the overwhelming volume of international cargo.

In this connection also, the Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Wastes was formally established in 2005. This network aims to develop an information exchange system among the competent authorities in East and Southeast Asian countries (Box 10.7).

Source: AFP.

Controlling Shipments of Outdated Secondary Goods

Countries should also consider passing import regulations for secondhand goods based on the year of manufacture. These are designed to prevent imports of secondhand goods that are liable to become waste a short time after import. Second hand goods, such as electrical and electronic equipment, should undergo testing before being shipped, such as is carried out in Australia.

A number of countries restrict and regulate the import of secondhand goods to protect the environment and their own industries. For instance, in 2003, Thailand imposed a ban on imports of used computers and household appliances more than 3 years old and on copy machines more than 5 years old; India prohibits imports of secondhand equipment more than 10 years old. Some countries also impose restrictions on imports of used refrigerators if they contain ozone-damaging coolants.[298]

It should be noted that there is a little statistical information on the flow of secondhand goods internationally. The Harmonized Commodity Description and Coding System (HS) code is considered as a possible way to capture the international transaction of secondhand goods. The HS code is an international method of classifying products for trading purposes. This classification is used by customs officials around the world to determine the duties, taxes, and regulations that apply to each product. However, the HS code is currently applied to only a few secondhand goods, such as used cars and clothes. The code does not currently apply to electric appliances, automobile parts, and construction machinery, which account for a large portion of the trade secondhand goods.[299]

Box 10.7: The Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Wastes

A network among officials from Asian countries in charge of the Basel Convention has been formed to exchange information and capacity building based on a proposal from the Japanese Government. The activities of the network are to

- develop an Internet-based information system that facilitates exchange and dissemination of information on illegal transboundary movements of hazardous wastes among parties in East/ Southeast Asia;
- identify, collect, and disseminate through the network, useful information on the control of transboundary movements of hazardous and other wastes in East and Southeast Asia;
- facilitate day-to-day communication among environmental authorities of the countries in East and Southeast Asia; and
- assist, primarily by providing information collected through the network, in designing, preparing, and organizing workshops, seminars, and other training events for capacity building in environmental authorities of the countries in North, East, and Southeast Asia.

Three workshops have been held to share the experiences on controlling illegal shipment of hazardous waste and to identify the further activity of the network. It is expected that this kind of effort will strengthen the capacity of competent authorities and the inspection of suspicious shipments.

Source: The Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Waste. Available: http://www.env.go.jp/en/recycle/asian_net/preface.html

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298 Kojima, Michikazu. 2005. Current Trade Flows in Recyclable Resources within Asia & Related Issues. *IDE Spot Survey* No. 29. Chiba: Institute of Developing Economics. May.

299 Kojima et al. 2007. *The Real Recycling Situation in Asian Region and Management of International Transboundary Material Recycling / 3R Policies*. Ministry of Environment, Japan.

Chapter 11. Conclusion

This report is built on two fundamental propositions. First, given the current inefficient development patterns of developing Asian and Pacific countries, the economies of the region cannot continue long to support the very high demand for renewable and nonrenewable resources without significant negative impacts from resource trends, including higher prices, severe degradation, and growing internal competition. Second, governments around the region have the ability to follow an alternative path to development that can not only help avoid these impacts, but can also take advantage of enormous opportunities to invest wisely in infrastructure and institutions for their future in ways that will simultaneously strengthen their competitive advantage, generate jobs and provide for a clean and productive environment.

The clock is running to avert global resource constraints and unmanageable amounts of wastes. Under current development patterns, the faster economic growth occurs, the worse the problem will become, because the intensity of natural resource use and the amount of pollutants discharged into the environment are not yet falling as fast as production is rising. Thus, economic growth may seem like a success, but the present track is leading to an inherently unsustainable and unstable condition. Finding ways to improve the resource efficiency of Asia's economies can help perpetuate the enormous benefits of economic expansion the region has enjoyed while minimizing the environmental and other associated costs. Through increased employment opportunities (and income generated) and reduced health and environmental impacts from harmful wastes, resource efficiency can also lessen the conditions that contribute to poverty, the major focus of the Millennium Development Goals (MDGs).

However, the potential impacts of Asia's growth extend well beyond its borders, especially with respect to climate change impacts. Much of the global increase in greenhouse gas (GHG) emissions over the next 20 years is expected to occur in the developing world, where emerging economies—such as the PRC and India—continue to base their economic development on heavy use of fossil energy derived from hydrocarbons. Climate change may result in wide-scale regional and global changes in the existing environmental and ecological balance. It is not an exaggeration, then, to say that the future of humankind and the planet will depend in large measure on the ability of the developing economies in this region to break from their current inefficient and environmentally damaging resource use patterns.

The second point made above is that governments around the region have the ability to follow an alternative path to development that can not only help avoid these impacts, but can also take advantage of enormous opportunities that lie ahead in the region. There are enormous investment requirements for economic infrastructure, and choices made now about the nature of these investments offer the chance to enhance long-run competitive advantage by leapfroging over older-generation technologies and greatly increasing resource efficiency.

This path involves countries shifting from current inefficient patterns of resource use and embracing more resource-efficient norms. On a planet that may push its limits in a number of areas (demographic, environmental, energy, and agricultural) within this century, nations must not only plan strategically about how to achieve far more resource-efficient economies, but they must also commit the financial resources and develop the political will to implement their strategies before it is too late.

The choice should be clear—make the necessary adjustments and gain the benefits now or pay dearly later. All countries in Asia and the Pacific face increased competition for resources and rising costs. They cannot afford to respond slowly to rapidly emerging constraints on environmentally sustainable economic growth. The adoption of new approaches to reducing, reusing, and recycling wastes are essential to the sustainable future of Asian economies.

This report has focused most of its attention on the roles that governments can play in this transition, and it has described a framework they can follow to start moving their economies toward greater resource efficiency. In describing this framework, the authors identified eight important roles for national and subnational governments, each elaborated in separate chapters of the report. This final chapter recaps these points, along with some of the important related examples and opportunities given throughout the report.

Role 1: Adopting Integrative Thinking to Change Perspectives and Decision-Making Processes

Responding adequately to mounting environmental challenges in the region demands greater integration and coordination across several dimensions of resource management. Major improvements in resource efficiency—not just modest incremental changes—are needed. Four important dimensions that policy makers need to consider are:

Integrative planning across economic, social, and environmental spheres. One of the keys to achieving sustainable development is recognizing that economic, social, and environmental systems are actually complementary, not in conflict. The three systems are coequal and interdependent, with major areas of overlapping interest. Structural reforms to address resource efficiency can offer benefits in two areas that policymakers might not expect—poverty reduction and job creation.

Materials, energy, water, and land as integrated systems. Integration for resource efficiency in policy making and investment should emphasize interactions and efficiency improvements among the basic resource flows and stocks, including materials, energy, water, and land. When focused on one type of resource, it is important to always consider how it interacts with others, because the production or use of each type of resource places demands on all the others. The policies and practices of sustainable agriculture illustrate the power of integrative planning and management to achieve high resource efficiency. The use of an integrated approach to resource management is also applicable and cost-effective for green building design and the planning of livable cities.

Integrative planning across naturally defined regions. Typical planning processes fragment different types of land use in a region, focusing on urban or rural or wild land without perceiving the interactions among them. Integrative regional planning seeks to optimize solutions by addressing multiple issues as a whole system. It may begin with a defined problem or a proposed solution. One area in which integrative planning is essential, for example, is making economic use of the huge amount of biomass waste overloading landfills around the region. The core issue is planning sustainable programs and initiatives to absorb this largest component of both urban and rural waste, while integrating its use with appropriate bioenergy production.

Integrative planning across time horizons—climate change. Policy makers and investors often plan over a relatively short time frame. They make choices that appear cost effective in the present but create major economic or environmental problems later. There are many principles, methods, and tools to support longer-term planning. One illustration of such planning relates to one of the most critical challenges facing the world: responding to the present impacts of climate change and preparing for the likely future impacts. Given the complexity of the causes and consequences of climate change, it is important to consider diverse scenarios of what may happen and determine what short- and mid-term initiatives are the best investments.

Role 2: Developing National Policy Frameworks

To bring about changes in the way countries use resources, it is vital to achieve a collaboration of government, business, civil society, and other stakeholders, all focused on developing and implementing a coherent and implementable national framework for greater resource efficiency. National frameworks range from overall development strategies to specific environmental standards and regulations.

Overarching policies. For the necessary reforms to occur, policy makers must first see resource efficiency as a means to improve economic performance and environmental quality and then establish policies through legislation or executive order mandating an integrative approach for all agencies with supporting capacity-building programs. Such policies should seek to optimize economic efficiency across the resource inputs of materials, energy, water, and land use. Policy makers should consider adopting life-cycle assessment as a basic component of policy and investment analysis.

Targets, monitoring, and benchmarking. In formulating policies to improve resource efficiency, it is vital to quantify problems, establish priorities, and monitor progress toward achieving them through benchmarking. Quantitative indicators can help indicate what needs to be changed and by how much. They also allow comparisons, either between governments or between companies, and are important for measuring the progress of government and business actions against predefined targets.

Policy and program instruments. Achieving resource efficiency requires careful analysis planning and coordinated execution of the chosen policies and programs, which can be broadly described in four categories: regulatory instruments, economic and financial instruments, information-based instruments, and voluntary initiatives. An optimal mix of environmental policy instruments will often include elements of more than one of these categories. Decision makers must carefully evaluate and select each policy instrument to be appropriate to the objective and to the setting.

Policies to promote materials, energy, and water efficiency. While countries should consider developing an integrated policy to promote resource efficiency, it is also important to establish sound policies that separately encourage greater resource efficiencies in the use of materials, energy, and water applying the policy instruments referenced above.

- Materials. In a number of Asian countries, national and local government leaders are developing and implementing upstream and downstream measures to deal more effectively with the enormity of their waste problems as part of national plans and programs to promote the 3Rs in waste management. Specific examples discussed in this report include: substance, product, or technology bans; take-back provisions; green purchasing regulations; biomass policies and programs; recycling programs; deposit-refund programs; performance bonds; and regulations for construction and demolition debris.
- Energy. Energy efficiency covers many diverse and distinct market segments, all targeting the creation of a low-carbon, sustainable energy future that is cognizant of climate change risks. Examples of policies include energy audits targeting industry, energy efficiency standards and labels for appliances and vehicles, energy pricing and taxation, favorable subsidies (tax credits and loans), financing through energy service companies (ESCOs), demand-side management, carbon (GHG reduction) projects, and net metering to allow excess electricity production from renewable sources to be sold back to the grid.
- Water. Reforming the water sector for greater efficiency must involve decision makers at all levels working together and hinges first and foremost on waster pricing. National and regional efforts must focus mainly on improving allocative efficiency of price mechanisms based on the "scarcity" value of water, while local efforts must focus more on improving the technical and productive water efficiency by increasing water recycling and water saving. It is crucial that efforts at all levels be mutually reinforcing and that they be implemented with full participation of the agencies and stakeholders involved, including surrogates (such as environmental nongovernment organizations [NGOs]) for the water needs of natural systems.

Role 3: Building Institutional Capacity

Without sufficient institutional capacity and arrangements, even the most progressive legislative reforms will fail to have the desired effect, and any efforts at economic or environmental planning can easily be compromised by political interests and mismanagement. As a result, scarce resources, such as water, materials, and energy, will continue to be used inefficiently. Most countries in the region face common institutional challenges, including: strengthening political awareness, building adequate capacity in key government and resource management institutions, clarifying roles among government agencies, optimizing budgetary allocations, enhancing access to justice, fostering public involvement, and generating and disclosing relevant information. Three of the most important institutional measures that developing countries can take to address these deficiencies are discussed in the following paragraphs.

Coordinating developmental and environmental policies. Any efforts to improve institutional capacity must be broad-based. They must target authorities in charge of environmental protection and sustainable development, those responsible for the coordination and integration among different sectors—agriculture, construction, education, environment, finance, health, industry, and transportation—and also those governing specific environmental areas, such as water resources management and energy planning. In coordinating with others, environmental agencies should address gaps and overlaps in authority, and ambiguity in operational roles. Possible cooperation mechanisms include interagency agreements that establish clear coordination procedures, joint research programs, and multi-agency committees or task forces.

Devolving authorities to local governments. Despite the challenges encountered in decentralizing environmental functions, national or central governments should continue their efforts to grant increased powers to regional or local authorities. Overall, devolution and autonomy can foster increased efficiency and equity. For many functions, regional or local authorities have a more complete understanding of conditions and needs and can better plan and implement responses within a national framework. The challenge is to strike a balance between which responsibilities are retained at the national level and those devolved to local levels. At a minimum, national agencies should retain authority over national standard-setting and policy making and issues related to transboundary pollution. National agencies should also retain ultimate enforcement powers over responsibilities devolved to local authorities. In this effort, it is important that national environmental agencies should build and strengthen the capacity of subnational units and provide the necessary oversight, implementation support, and coordination.

Increasing financial resources. According to recent estimates, government spending on environmental protection amounts to less than 1% of gross domestic product (GDP) in Asia and the Pacific. Under these budgetary constraints, environmental agencies in many countries in the region are hindered in effectively repairing and upgrading environmental infrastructure, as well as investing in strengthening technical skills of officials. Insufficient resources also prevent investment in supporting facilities to upgrade production equipment and apply advanced technology to treat wastes by domestic enterprises. Clearly, countries need to increase their budgetary allocations for environment protection—including those aimed at improving resource efficiency—beyond present regional norms.

Role 4: Supporting Local Action

The critical role of local authorities in promoting resource efficiency should not be overlooked. Because local governments have jurisdiction over the large populations living and working within their boundaries, they are in a good position to influence the habits that cause inefficient resource consumption patterns. Local initiatives are most effective when supported by comprehensive national legislation and national programs, especially those that provide incentive mechanisms for local governments. Community-based organizations and NGOs also play an essential role in local programs, especially in the areas of public awareness and education. Meanwhile, international agencies and organizations can do their part by channeling financial and technical support to the local level and by fostering collaboration to provide a common platform to share ideas, experiences, and knowledge.

Solid waste management. The cities that have enjoyed the most success in managing their wastes have typically combined conventional solutions with affordable and community-based solutions that work well in a developing country context. This typically includes considering the contribution of informal waste collectors and resellers (waste pickers or scavengers). Local programs, often supported by NGOs, can improve resource efficiency, help create jobs, protect the environment, promote community participation, and encourage and support entrepreneurship.

Energy efficiency and reducing greenhouse gas emissions. When cities plan and develop with energy efficiency and reduced GHG emissions in mind, per capita energy consumption for municipal, residential, and transportation needs can be cut significantly. While they cannot legislate national carbon taxes or mandate nationwide changes in the fuel mix for electricity, local governments can choose to either mitigate GHG emissions and contribute to the solution or they can exacerbate unsustainable energy practices that waste money, cause air pollution, and contribute to climate change. Since local governments design and manage public assets and operations, such as buildings and facilities, they frequently have regulatory influence or responsibility for building codes, make or influence infrastructure decisions and investments that determine energy use in the transportation sector, and control local land-use policies.

Water efficiency. While large-scale, capital-intensive projects are needed where feasible and appropriate, some of the most promising measures to improve the efficiency of water use are being mounted in households, farmers' fields, villages, and city neighborhoods across the developing world. If such efforts are to expand, local authorities need to operate within a national framework that includes water codes, laws, and regulations, including sound water pricing. Local strategies work best when complemented by national and international programs of resource management and conservation, as well as by scientific research and extension programs to develop and popularize ways to increase water efficiency. Because agriculture is a major consumer of water resources in most countries, much local effort should be focused on developing more sustainable agricultural water management systems alongside the introduction of irrigation or groundwater pumping fees.

Role 5: Investing in Resource-Efficient Infrastructure

Developing countries need to invest in all types of infrastructure, including energy, transport, and water, to improve living standards and to achieve the MDGs. Infrastructure investments often establish a country's pattern of resource use for decades to come. If conventional low-efficiency infrastructure continues to be introduced, the economies and the sustainability of resource use will suffer in the long term. Thus, private and public investors in developing countries should consider opportunities to bypass outmoded or conventional infrastructure solutions, that is, to "leapfrog" over them by shifting investments to highly resource-efficient alternatives that are readily available. These include renewable energy sources, energy efficient buildings and lighting schemes, modern sanitary landfill designs, pedestrian-friendly urban areas, electronic information management and communication systems that lower paper demands and the need for travel, mass transit systems, integrated water resources management solution, and demand-side management for all resources. The report gives three examples to help illustrate this point:

Centralized versus decentralized wastewater systems. For many developing countries, there are a number of disadvantages in investing in costly, centralized systems. Capital-intensive systems take up considerable urban land and import technologies that are typically inappropriate; and large-scale systems rarely pay for themselves out of revenues generated in developing countries. Decentralized wastewater systems can reduce public investment, increase efficiency of water use, generate renewable energy and organic fertilizer, and avoid solid waste disposal of sludge.

Landfills and incinerators versus resource recovery and recycling. Because of the rapidly increasing volume of waste, the cost of its disposal is growing. Yet, many cities that are finally starting to address their waste management problems are turning primarily to conventional solid waste management solutions, such as sanitary landfills or incineration that focus on improving downstream disposal, while failing to fully pursue upstream options to reduce the waste load. To be truly cost efficient and sustainable, equal attention should be paid to upstream options to reduce waste for final disposal and to reuse and recycle valuable resources. Governments should be responsible for promoting appropriate and cost-effective technologies and infrastructure investments to manage partly recyclable products and unrecoverable wastes properly.

Conventional versus green buildings. The energy performance of buildings will become increasingly important to the energy outlook of Asian countries, as the built environment continues to expand throughout Asia. Initial design of a building or retrofitting an existing one can greatly reduce the energy, water, and other resources needed for the life of the facility. High-performance design creates the possibility that the building's management or owner can even gain revenues from selling energy and recycled resources internally or externally. The cost savings alone may pay back added costs of the resource-efficient design in relatively few years. Further savings can be gained through energy conservation practices building operation. Most of the known high-performance innovations have been demonstrated to be cost effective in the operation of hotels, apartments, office buildings, and individual residences.

Role 6: Promoting New Technologies and Solutions

A big part of government's role in promoting resource efficiency is supporting the development and/or transfer of promising technologies. Governments set policies for manufacturing and service firms and for the operation of their own facilities and services. Governments are themselves major investors in environmental technology and research and development (R&D), and play a role in regulating and guiding private investors, such as banks and investment funds. They also have the power to reduce subsidies that discourage development and to introduce incentives for innovation through market-based and other policy measures. The private sector is more likely to invest in new technologies if public policy provides a favorable government regulatory framework that permits full cost recovery and a market environment that rewards efficiency improvements. All these functions give government special leverage in promoting innovation, designs and application of new technologies and other resource-efficient investments.

Research and development. For national governments, promoting R&D is central to supporting investment in the environment and energy industries for resource efficiency. Most new technologies originate in the more developed countries, although some adaptations of these technologies or indigenous technologies are also produced in developing countries. R&D may be carried out by educational and research institutions, by industry institutes, and by the companies themselves. Government can encourage R&D by creating appropriate market incentives for environmental and resource efficiency improvements (tradable permit schemes, performance bonds, removal of perverse subsidies and careful use of grants or tax breaks to encourage innovation), providing grants through nonprofit institutions, and by making purchase commitments to create market demand. Green industrial parks can also help centralize research and extension services by providing a home for new and expanding businesses. Governments can also work with business associations, incubator services, and the research community to improve the success of investment in various sectors.

Technology transfer. Another strategy is to promote technology transfer by supporting partnership development with companies in more developed countries. Companies based in the European Union, Japan, and United States are rapidly entering the growing Asian market for the provision of infrastructure as well as environmental goods and services, competing with local firms. However, they often benefit from joint ventures with these same firms and are themselves employers of the local workforce. In many cases, a foreign company with an advanced technology may be relatively small and needs to partner with local entrepreneurs and technologists to market their innovations. Even larger firms usually find market entry in Asia and the Pacific easier in partnership with local entities.

Technology evaluation. Competent, systems-based evaluation of environmental technology innovations is essential for understanding how they can most effectively be deployed and for beginning their cost-effective use earlier in the development cycle. An important role for technology evaluation is assessing their commercial-scale application, and government agencies can help to remove barriers to market entry through such assessments.

Role 7: Supporting Industry Awareness and Change

More than 50 million companies are now operating in Asia, but few have been leaders in environmental performance. Many remain oblivious that their competitiveness is already at stake in a business world that is rapidly catching on to the benefits of "going green." Countries may find it worthwhile to develop sector-specific programs for industry to promote more efficient resource use. Environment authorities need to engage actively with the business community they regulate, including small and medium-sized enterprises (SMEs), to agree on clear and fair targets for resource efficiency improvement. Government actions specifically targeted at industry include the following:

Raising awareness and capacity. Disseminating best industry practices can provide firms with both useful information that they can use to alter their own practices, and a reference point as to how they are doing relative to the entire industry. Practices may be defined by a government agency or the government may provide assistance to industry sector institutes to identify and disseminate the practices. There are a range of organizations that can help in the effort to disseminate and showcase best practice, management tools, and technologies—including information clearinghouses and networks, extension services and technical assistance systems, industry clubs or associations, demonstration projects, and training facilities.

Co-regulation. With appreciation growing of the limits facing conventional policy instruments, many governments are encouraging the adoption of self-regulatory and co-regulatory policy instruments. The basic concept of voluntary initiatives is that more can be accomplished through a negotiated partnership between government and the private sector than through enforcement of regulations alone. They come in an infinite variety of forms and include any relationship in which the government, a firm or a business sector or a particular locality or consumer group agree to mutually beneficial terms to solve a commonly defined problem. Examples include: negotiated agreements between the firm and the regulatory body; auditable environmental management systems (e.g., ISO14001); and public-private partnerships between industry and government or industry and civil society to achieve agreed objectives and self-enforced industry codes of practice.

Informational measures targeting industry. Governments can further stimulate the adoption of appropriate industrial practices through informational measures. Action can be taken in a variety of areas, including ecolabeling schemes, public disclosure of firms' environmental performance, energy audits, and environmental accounting systems.

Eco-industrial park development. Several Asian countries have established programs to transform existing industrial parks or estates into eco-industrial parks. In a few instances, these programs aim at developing new parks, but most have started by implementing shared waste management schemes and have sometimes moved on to experiment with industrial symbiosis, seeking exchange of by-products among companies. A firm's decision to locate in such a park can provide lower waste management costs, access to resource efficient technologies and services, and new business opportunities.

Role 8: Participating in Regional and International Initiatives

Many of the efforts in Asia to increase the efficiency of resource use will be strengthened through regional cooperation and integration. This is especially true in addressing problems associated with hazardous wastes and transboundary pollutants. This report examined two important elements of regional cooperation related to resource efficiency: information sharing/capacity building and promoting the safe trade of secondary materials.

Regional information sharing and capacity building. Information sharing at the regional and international levels is critical to harmonizing policies and reducing the gap between countries in recycling-related institutional structure and recycling and management capacity. Sharing the experience of developed countries regarding recycling and waste management mechanisms can be useful for such capacity development to help improve systems for collection, transport, treatment, storage, recovery, and disposal.

Promoting the safe trade of secondary materials. The expanding trade in materials that are used by-products of consumer or producer actions offers both opportunities and threats in terms of Asia's environment and its sustainable development prospects. Depending on how such secondary materials are handled, trade can either complement waste minimization in the region or significantly increase environmental pollution and human health risks. Particularly troubling are the hazardous materials that form part of existing transboundary movements. This includes hazardous wastes contained in secondhand goods—older finished consumer products that are partly recyclable—including electronic and computer equipment (e-waste) and used vehicles. Although the establishment of the Basel Convention represented the start of international efforts to control transboundary movements of hazardous wastes, illegal traffic is still prevalent. Both exporting and importing countries must strive jointly to prevent the transfer of environmental pollution and health risks that can result from transboundary movements of wastes. The problem is complex, and a comprehensive solution will require a range of remedies, including passing and enforcing tougher national laws, tracking shipments of secondary materials, and controlling shipments of secondhand goods.

In Conclusion

With collaboration and perceptive planning, the nations of Asia and the Pacific can identify the needed policy measures, institutional reforms, technological innovations, and associated investments that will put the region's economic growth onto an environmentally sustainable path. By appreciating their common interests and objectives, governments the private sector, civil society and other stakeholders and partners can accomplish much more collaboratively than separately in building resource efficient economies that will contribute to a sustainable future.

About Toward Resource-Efficient Economies in Asia and the Pacific

Much attention is being given to the environmental consequences of rapid economic growth in Asia and the Pacific. Among other impacts, changing production and consumption patterns affect waste generation, including minerals and other raw materials, energy, and water, and they also are driving up greenhouse gas emissions. Resource efficiency in developing Asia is low by global standards, meaning that the resources used per unit of economic output are high. Such inefficient patterns of resource use contribute to higher than necessary production costs, and the waste disposal impacts of consumption often are not reflected by the market.

This report reviews the economic and environmental consequences of resource inefficiency in Asia and the Pacific and some of its underlying causes. It examines a range of technical, policy, and institutional responses to encourage corporations and consumers alike to adopt more resource-efficient behaviors, with particular attention to the vital role governments must play in creating incentive structures, encouraging research and development for new technologies, improving institutions and information exchange, and other measures to move the region's economies toward greater resource efficiency. This analysis is a contribution to the global G8 3R Initiative, which seeks to promote the "reduce, reuse, recycle" approach to waste management. While many of the specific strategies described are not new, the report should contribute to an understanding of the underlying reasons behind resource inefficiency, tools for its analysis, and specific interventions tailored to the Asia and Pacific context.

About the Asian Development Bank

ADB aims to improve the welfare of the people in the Asia and Pacific region, particularly the nearly 1.9 billion who live on less than $2 a day. Despite many success stories, the region remains home to two thirds of the world's poor. ADB is a multilateral development finance institution owned by 67 members, 48 from the region and 19 from other parts of the globe. ADB's vision is a region free of poverty. Its mission is to help its developing member countries reduce poverty and improve their quality of life.

ADB's main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

ADB's headquarters is in Manila. It has 26 offices around the world and more than 2,000 employees from over 50 countries.

About the Institute for Global Environmental Strategies

The Institute for Global Environmental Strategies (IGES), established by an initiative of the Japanese Government in 1998, is a research institute that conducts pragmatic and innovative strategic policy research to support sustainable development in the Asia and Pacific region.

IGES will enhance collaborations with a broad range of stakeholders, such as national governments, local authorities, businesses, nongovernment organizations, citizens, and experts, to carry out strategic policy research from an Asia-Pacific perspective and to disseminate the results around the world, so that it can contribute to the transition toward a sustainable society.

IGES, together with the Ministry of the Environment of Japan, United Nations Centre for Regional Development, United Nations Environment Programme/Regional Office for Asia and the Pacific, and ADB, contributes to the promotion of the 3R Initiative by conducting policy research, examining regional strategies, and promoting networking.

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