ADB

MAKING PROFITS, PROTECTING OUR PLANET

CORPORATE RESPONSIBILITY FOR ENVIRONMENTAL PERFORMANCE IN ASIA AND THE PACIFIC

ASIAN ENVIRONMENT 2005 OUTLOOK

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Preface

An economic revolution is sweeping through Asia and the Pacific, led largely by the world's two population superpowers: the People's Republic of China (PRC) and India. Today, there are 250 million and 300 million people from the PRC and India, respectively, that have joined the world's middle class, and it is estimated that the ranks of these consumers will swell to 500 million in each country—one billion people—by 2020.

This economic revolution has created a large new market for goods and services, and it has the potential to lift hundreds of millions more out of poverty. It presents huge opportunities for entrepreneurs, government leaders, and private citizens. But as the authors of this report observe, this phenomenal economic growth will put greatly increased pressure on natural systems and the assimilative capacity of the planet.

No individual, organization, or government can stop the grand economic revolution underway in this region. Nor should anyone attempt to slow down this growth. The hundreds of millions of people still living in poverty in Asia and the Pacific are entitled to a better quality of life.

But if the region's leaders use yesterday's technology and antiquated thinking to drive this economic revolution, environmental degradation is likely to increase so dramatically that public health and ecosystems are placed at severe risk. If they turn instead to the best available technologies and environmental management approaches, these threats to the very foundation of the economic miracle can be minimized. Only if governments and the corporate sector take such steps can societies in Asia and the Pacific, and the entire world, enjoy the benefits of economic success without placing the public and the natural environment at risk.

The authors remain optimistic that good governance, strong management, true entrepreneurial spirit, and an increasingly aware and environment-conscious public can combine to retain the benefits of rapid economic growth while protecting the environment and human welfare. Much of the world is moving rapidly beyond the industrial economy toward a knowledge-based society and economy. This has the potential to enable Asia and the Pacific to meet its poverty reduction goals and improve the quality life for all.

The relatively narrow "cleaner production" approach has been used for a decade to characterize goals and methods for achieving environmentally beneficial productivity gains for the private sector. Indeed, the Asian Development Bank (ADB) has supported a variety of policy and technical measures to promote cleaner production, having contributed more than $10 million in grants for technical assistance projects and lending some $3.3 billion for projects with cleaner production components over the past 15 years.

Our conviction that something more than this approach is now needed to respond to the unprecedented environmental strains facing our region—combined with the need for a better understanding of the private sector's role—led to our commissioning of the *Asian Environment Outlook 2005*. Its analysis shows that the chance for a firm to improve its eco-efficiency is only a relatively minor part of the newly emerging reasons for the private sector to pay far greater attention to environmental performance.

For too long the region's leaders across the public, private, and civil spheres have failed to give the environment the serious consideration it deserves. Environmental laws are in place, but often, they are not enforced. Cleaner technology is available, yet society fails to invest in it. Environmental goods and services create new market opportunities, but only a few entrepreneurs have seized them. Many are so busy getting rich that they ignore storm clouds on the horizon that may wash away the very basis of their prosperity.

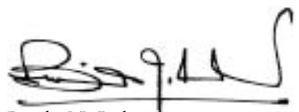
Government leaders should stop blaming industry for all environmental degradation. They need to create an enabling environment that will unleash the creative and entrepreneurial spirit within the business sector to conduct business in an environmentally responsible manner.

Business leaders should stop placing the burden for environmental protection on governments. They need to invest in new cleaner production processes, invent new manufacturing methods and products, and manage their entire supply chain. If they fail, the rising Asian middle class and consumers in North America and Europe will be less inclined to buy their products. Those who innovate and provide value will capture market share. Today's polluters will be tomorrow's dinosaurs.

Civil society should work with both government and business to stop environmental degradation. In democratic societies, the public should use its voting power to support leaders protecting the environment. It should use its purchasing power to support companies providing more environment-friendly goods and services. And it should learn how to identify and reduce consumption of environmentally damaging goods.

The central thesis of this report is that Asia and the Pacific needs a grand coalescence of government, business, civil society, and others—all focused on creating a sustainable future. Pressure to improve environmental performance is looming—from global trends, tightening national regulatory systems, and the dynamics of the marketplace and corporate stakeholders. Human ingenuity led Asia and the Pacific into the environmental morass that confronts the region today, and only human ingenuity can lead it to a sustainable future. Innovation and creativity will form the basis of tomorrow's successful corporations, leapfrogging over old and dirty technologies and management practices and embracing new approaches already available and still to come. These progressive corporations will make profits while protecting the planet.

The future of our children, our grandchildren, of our ecosystems, and of the planet itself are at stake. Our heirs will be unforgiving if we fail to take action today to ensure a sustainable future. This is why every leader in Asia and the Pacific should read this report, heed its messages—and then act. It will not be easy. But we have the ability to reinvent ourselves as individuals, as organizations, as responsible corporations, as enabling governments, and as partners in creating a sustainable future for all in Asia and the Pacific.



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Any report of this type is a team effort, and completion of *Asian Environment Outlook (AEO) 2005* would not have been possible without the valuable inputs and assistance of many. A core team of authors prepared the initial draft of the report. They comprised David Annandale, Albert Fry, and William Halal and were led by Peter King, Advisor, Asian Development Bank (ADB). The report was brought to completion by David McCauley, Senior Environment Economist in ADB's Environment and Social Safeguard Division, with the assistance of Consultant Communications Specialist Rachel Salazar. Substantive inputs also were provided by Jeffrey Bowyer, Consultant. Copyediting was done by Judy Goldman, and the firm DoubleSlash designed the book layout as well as all other presentation materials relating to the report.

On behalf of the team, I also wish to thank colleagues and friends who participated in the various consultations organized during preparation of the report who provided important feedback on its several drafts. In October 2004, the core authors attended a European workshop on Corporate Responsibility for Environmental Performance in Asia and the Pacific held in conjunction with the annual meeting of the World Business Council for Sustainable Development (WBCSD) in Amsterdam. A selected group of about 20 participants met, comprising company representatives with supply chains deep into Asia as well as WBCSD representatives from the region. In November 2004, the Greening of Industry Network Annual Meeting in Hong Kong, China, with the theme "Partnerships for Sustainable Development," afforded opportunities for valuable consultation and feedback concerning the report's preliminary findings. The Fifth Ministerial Conference on Environment and Development held in March 2005 in Seoul, Republic of Korea also provided ADB a chance to consult on the emerging findings of the report with an international audience drawn from governments, nongovernment organizations, the private sector, development agencies, and civil society.

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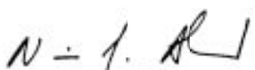

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Acronyms and Abbreviations

ADB	Asian Development Bank
AEO	Asian Environment Outlook
AI	artificial intelligence
APEC	Asia Pacific Economic Commission/Asia Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
B2B	business-to-business
BAPEDAL	Badan Pengengdalian Dampak Lingkungan (Indonesia Environmental Impact Management Agency)
CERES	Coalition for Environmentally Responsible Economies
CFC	chlorofluorocarbon
CNG	compressed natural gas
DNA	deoxyribonucleic acid
EIA	environmental impact assessment
EMS	environmental management system
EPCA	environment and pollution control agreement
ETA	environmental technology assessment
EU	European Union
FANTASIE	Forecasting and Assessment of New Technologies and Transport Systems and their Impacts on the Environment
FSC	Forest Stewardship Council
GATT	General Agreement on Trade and Tariffs
Gbps	gigabits per second
GEO	Global Environment Outlook
GEN	Global Eco-Labeling Network
GHG	greenhouse gas
GMF	genetically modified food
GMO	genetically modified organism
GRI	Global Reporting Initiative
IFC	International Finance Corporation
IMF	International Monetary Fund
ISO	International Organization for Standardization
IT	information technology
JPOI	Johannesburg Plan of Implementation
LCA	life cycle analysis (assessment)
Mbps	megabytes per second
MCED	Ministerial Conference on Environment and Development
MDGs	Millennium Development Goals
MEA	multilateral environment agreement
MEMS	micro-electro-mechanical systems
MNC	multinational corporation
MSC	Marine Stewardship Council
NASA	National Aeronautics and Space Agency
NEAP	national environmental action plan
NEPP	national environmental policy plan
NGO	nongovernment organization
NSDS	national sustainable development strategies

NSF	National Science Foundation
OECD	Organisation for Economic Co-Operation and Development
PC	personal computer
PRC	People's Republic of China
PROPER	Program for Pollution Control, Evaluation and Rating
SAM	Sustainable Asset Management
SEC	Social and Economic Council
SEPA	State Environment Protection Agency
SETAC	Society for Environmental Toxicology and Chemistry
SME	small or medium enterprise
SRI	socially responsible investment
TRIPS	Trade in Intellectual Property Rights Agreement
UK	United Kingdom
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNFCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation
US	United States
USEPA	United States Environmental Protection Agency
VA	voluntary agreement
VR	virtual reality
WBCSD	World Business Council for Sustainable Development
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WWF	World Wide Fund for Nature

Executive Summary

Sustained economic growth in Asia and the Pacific—especially in the People's Republic of China (PRC), India, and part of Southeast Asia—has led to a rapid decline in income-based poverty. Unfortunately, this has been accompanied by a corresponding rise in pollution and the degradation of natural resources.

Many of these negative impacts on the environment are of such magnitude that they are of global concern. Air and water pollution continue to rise, and solid waste management—especially in the region's rapidly expanding urban areas—is becoming an enormous problem. Deforestation continues alongside coastal and marine degradation. And the region is rapidly becoming the world's largest source of greenhouse gas emissions. This has undermined some of the impressive development gains achieved because of increasing health care costs associated with the effects of pollution as well as heightened vulnerability of the mostly rural poor who depend upon productive natural resource systems for their livelihoods.

With these growing environmental problems, easier access to information sweeping the region, and a rising middle class giving greater consideration to their quality of life, both the public and private sectors are increasingly being forced to pay much greater attention to environmental management.

Making Profits, Protecting Our Planet: Corporate Responsibility for Environmental Performance in Asia and the Pacific is the second report in the *Asian Environment Outlook* (AEO) series published by Asian Development Bank. It builds on work initiated through AEO 2001, which reviewed environmental policies and institutions employed across the region and found most countries relying on weakly enforced and largely ineffective environmental regulations based on top-down approaches. AEO 2001's conclusions focused on the need to explore a much wider range of more market-based and flexible policy instruments to complement stronger enforcement of existing policies and standards. It also encouraged better mainstreaming of environmental considerations into economic and sectoral policies and programs. While there has been some progress in these areas—and nearly all countries now have cabinet-level environment ministries—AEO 2005 argues that there is still a critical missing ingredient in the pursuit of a sustainable future for Asia and the Pacific: a fully engaged corporate sector.

Changing Expectations

There are mounting legislative, social, and market pressures on the corporate world to exercise greater responsibility for its environmental performance. These may serve as positive forces to help reshape the public-private compact concerning accountability for protection against pollution and resource degradation during economic development, and to accelerate the movement toward the widespread use of more sustainable production processes.

Responses to new pressures may be found in the private sector's widening interest in globally recognized environmental management certification programs such as the International Standard Organization's ISO-14001 and growing acceptance of the principles and practices behind the United Nations Global Compact for Corporate Citizenship in the World Economy, the Global Reporting Initiative (GRI), and the Equator Principles applied to large private investments.

ISO-14001 certification has grown rapidly in Asia and the Pacific, with the region now accounting for over 40% of the world's total. The number of certified firms in the PRC alone grew by more than 200% to 8,865 in 2005 from 2,802 in 2002. More than 700 corporations—many of whom operate in Asia and the Pacific—have adopted the GRI Sustainability Reporting Guidelines. And 35 of the world's largest banking groups—with the majority active in this

region—have signed on to the Equator Principles, accounting for about 90% of global project financing and amounting to $50 billion annually in loans.

Those who respond early to these global pressures can expect some competitive advantage through a mix of efficiency improvements, product differentiation, and risk reduction. There is evidence that, for many types of production processes, greater attention to waste minimization and other environmental management measures can result in productivity gains. In Thailand, more than 600 firms participating in an eco-efficiency improvement program achieved an aggregate 47% return on such investments.

There also are growing opportunities for increased revenues through product differentiation to meet the requirements of importers and the expanding "green product" demands of both consumers and shareholders. In India, textile and handicrafts firms have benefited from marketing their products to environmentally conscious consumers in Europe. Threats to brand reputation and environmental liability risks also are creating incentives for companies to pay greater attention to their environmental practices. The regional and global press is giving ever-greater coverage to stories about firms at odds with local communities over their environmental or social policies.

New Policy Thinking

While the credible threat of punitive government action must remain, there is tremendous scope for the expanded use of market-based incentives and a new set of promising policy measures centered on capturing growing corporate willingness to work in partnership with government and other stakeholders to see that public environmental and social expectations are met. Such voluntary agreements offer attractive supplements to command-and-control and market-based policy measures. These reflexive regulatory systems—already being tested in the tanneries and textile sectors in Indonesia, Pakistan, and Sri Lanka—can provide freedom for firms to find cost-effective methods of compliance, combining with other policy instruments to induce innovation and the private sector's adoption of a new set of "sustainability tools" such as ISO 14001 certification and improved corporate environmental metrics using life cycle analysis and other measures.

Encouraging Innovation

Though technological innovation alone cannot solve the serious environmental problems facing the Asia and Pacific region, some recent trends—especially toward energy efficiency in transport and manufacturing, alternatives to fossil fuels, and reduced end-product waste—provide encouraging evidence that rapid economic growth and sound environmental management can go hand-in-hand. Greater attention to establishing economic and environmental policy regimes that encourage such innovation is vital if the negative environmental by-products of economic expansion are to be kept within nature's assimilative capacities.

New and greener products—together with an anticipated massive investment in environmental infrastructure throughout the region—also show that environmental cleanup and protection offer strong business and employment opportunities. The global market for environmental goods and services is estimated to be about $607 billion in 2005, and is projected to grow to over $836 billion by 2015. The Asia-Pacific market accounted for $37 billion of this total, but its growth rate is the fastest in the world, with the market expected to triple by 2015.

A Collaborative Future

More direct interaction between government and the business community holds an important key to getting the region's development pattern onto an environmentally sustainable path. The public and private sectors in the region—as well as its citizens—must make these adjustments to define new production and consumption patterns that can satisfy human desires within environmental bounds. Now is the time to make these changes in the way Asia and the Pacific goes about the business of economic development.

CHAPTER 1

Background

Rapid economic growth has swept through Asia and the Pacific in recent years—a trend that is drastically changing the nature and scale of humanity's impact on natural ecosystems and the carrying capacity of the planet. While there are still terrible problems with entrenched poverty, hundreds of millions of people in the region now have a chance to experience a life beyond basic survival.

The sustained annual growth rates of 10% or more in the People's Republic of China (PRC), for example, have helped to reduce the number of people existing on less than one dollar a day from 473 million in 1990 to 284 million in 2001.[1] The Chinese Academy of Social Sciences estimates that 19% of the PRC's 1.3 billion, or about 250 million people, are now considered middle class—living in households with assets of between $18,000 and $36,000. It further forecasts that if this middle class keeps growing by 1% each year, then 40% of the PRC's population—almost 500 million people—will reach this status by 2020.[2]

The other Asian population superpower, India, counts a further 300 million out of its 1.08 billion citizens who have joined middle class ranks. Other statistics indicate that there are now more middle- to high-income earners—whom the United Nations Environment Programme (UNEP) defines as those earning in excess of $7,000 per annum—in Asia and the Pacific than in America and Europe combined.[3]

While public policies and investments have been crucial to these achievements, dynamic corporations in Asia and the Pacific have played a large part in delivering such impressive economic gains. These also have been buoyed by the region's first relatively peaceful period in generations with mostly stable governments, better educated and highly productive workforces, and a wide range of new opportunities opened by the phenomenon of globalization. Upwardly mobile populations, including millions lifted out of poverty over the past few decades, now look forward to their "turn" to share in the planet's wealth. To them, it may seem churlish to point to what may appear to be relatively minor environmental threats associated with the region's economic and demographic changes.

A closer look, however, reveals that these threats must be addressed if the positive aspects of growth are not to be undermined by declining environmental quality. Most problems are derived from the accelerating consumption demands of the new middle classes that are adding to the existing planet-wide resource use and waste disposal demands of developed countries. Asia and the Pacific already face major environmental problems that vary by location but include (i) air pollution (particularly high levels of particulate matter in cities); (ii) reduced availability and quality of freshwater supplies; (iii) desertification, deforestation, and other forms of land degradation; (iv) dust and haze; (v) acid rain; (vi) greenhouse gas (GHG) emissions; (vii) loss of biodiversity; and (viii) the degradation of marine and coastal resources.[4]

Compounding problems are caused by growing populations and the pressure to meet the demands of increasing numbers of people understandably wishing to enjoy the trappings of middle-class life. If the PRC, India, and Indonesia all reach the current average global car ownership rate, for example, then 200 million new vehicles could be on the planet's roads over the next few decades.[5] This is twice the number of cars currently owned in the United States (US). Continued growth in the use of both renewable and nonrenewable

resources will lead to an inevitable expansion in the size of developing countries' "ecological footprints."[6] The amount of productive land needed per person in 1999 to support patterns of consumption in the US (9.7 hectares), Canada (8.8), and Australia (7.6), was far higher than that in the PRC (1.5 hectares) and India (0.8), although the total footprints of the latter two countries are obviously greater due to their huge populations.[7] By comparison, the sustainable average footprint for the globe is estimated to be 1.8 hectares. Table 1 shows the ecological footprints of selected countries based on a study conducted by World Wide Fund for Nature (WWF).

Increases in per capita consumption in Asia and the Pacific soon will enlarge both per capita and national footprints substantially. The Worldwatch Institute estimates that if everyone on the planet reached 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. Underlying these predictions are extraordinary emerging consumption statistics from the region as it rapidly industrializes. For example, 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 used in the PRC alone. Of personal consumption items, roughly 35% of the world's cigarettes, 20% of mobile phones, and 23% of televisions were sold in the PRC.[8] With that country's 1.3 billion people experiencing double-digit disposable income growth, catering to the demands of four more "Americas" in the coming decade is an enormous business opportunity but also a daunting environmental prospect.

Clearly, it would be foolish not to think about and plan for the strains that this economic activity will place on natural resources and the environment if current trends continue. Economic expansion that severely erodes the base of natural capital may eventually undermine the viability of the region's economy through greatly elevated resource prices and high environmental burdens on society. There are already strong indications that we may have "overshot" the Earth's ecological limits in relation to some resources and waste sinks. The challenge is how to make growth environmentally sustainable so that it can continue to serve the needs and wants of the human population while conserving the natural assets and ecosystem services that make economic and social advancement possible.[9]

Underlying these problems are some strongly held ideas about the relationship between the environment and economic development that shape both public and private policies, some of which are challenged in this report. One widely held theory is that pollution naturally gets worse as economies develop until a certain level of affluence is reached, and then the wealth generated can be used to promote better environmental performance. Several countries in Asia and the Pacific have taken comfort in this theory and have followed a "grow now-clean up later" approach to their economies and environments.[10]

If this pattern were to hold in Asia and the Pacific, however, the environmental quality prognosis in the region would be dire. Fortunately, there is growing evidence suggesting that this is not likely to be the case. The World Bank's *New Ideas in Pollution Regulation* project shows that today's factories are, in many cases, less polluting than those of the past, and industrial pollution levels are falling even in some areas of developing countries where growth is most rapid.

Table 1: Ecological Footprints of Selected Countries

Country	Hectares/person			Change per capital (1991-2001)	
	Ecological Footprint	Biocapacity	Ecological Deficit	Ecological Footprint*	Biocapacity**
Global	2.2	1.8	0.4	-2	-12
US	9.5	4.9	4.7	7	-11
Asia Pacific	1.3	0.7	.60	6	-11
Australia	7.7	19.2	-11.5	16	-6
New Zealand	5.5	14.5	-9	16	-13
Japan	4.3	0.8	3.6	6	-6
Republic of Korea	3.4	0.6	2.8	30	-12
Malaysia	3.0	1.9	1.1	10	-48
Mongolia	1.9	11.8	-9.9	-33	-11
Thailand	1.6	1.0	0.6	20	-1
PRC	1.5	0.8	.8	14	-7
PNG	1.3	2.6	-1.3	-8	-16
Indonesia	1.2	1.0	0.2	4	-14
Philippines	1.2	0.6	0.6	-6	-22
Sri Lanka	1.1	0.4	0.7	20	-12
Cambodia	1.1	1.0	0.1	9	-3
Lao PDR	1.0	1.4	-0.4	-4	-12
Myanmar	0.9	1.3	-0.4	10	1
Viet Nam	0.8	0.8	0.0	14	6
India	0.8	0.4	0.4	1	-15
Pakistan	0.7	0.4	0.3	2	-18
Nepal	0.6	0.5	0.2	-4	-12
Bangladesh	0.6	0.3	0.3	0	-11

Source: World Wildlife Fund. *Living Planet Report.* 2004. Washington, DC.
* Ecological footprints change with population size, average consumption per person, and resource efficiency.
** Biocapacity changes with the amount of biologically productive area and its average productivity.

DEVELOPMENT AND THE ENVIRONMENT IN ASIA AND THE PACIFIC

Extensive data from environmental regulatory agencies in PRC, India, Indonesia, Republic of Korea, Philippines, Sri Lanka, and Thailand among others, show a positive relationship between a rise in per capita income and national enforcement of environmental regulations—even at relatively low levels. The fastest decline in pollution intensity appears to occur as countries move toward achieving middle-income status, not after:[11] it falls by 90% as per capita income rises from $500 to $20,000.

Modern relationships between industrial development and environmental quality are complex. Environmental performance improvements seen in developing countries of similar characteristics are by no means uniform. Even in the same country and sector, some corporations exhibit marked environmental performance improvements while others lag behind. This trend is also evident in developed countries.[12] Why environmental improvement is occurring in some countries well before they become affluent is further examined later in the report. The important lesson is that the early stages of economic development do not have to be characterized by environmental degradation. There appear to be many examples of growth occurring in poor countries even as environmental standards are maintained.

Another common perception challenged in this report is that environmental protection is solely the responsibility of government.[13] Agencies responsible for environmental management in Asia and the Pacific tend not to have the political power of their counterparts in other sectors, and they are often chronically understaffed and underfunded. Enforcing environmental regulations has proven to be difficult, especially where corruption is often a less expensive alternative than compliance with the law. An underlying business philosophy has been to get away with as much as possible, to comply only if the penalties are high enough, and to maximize profits without thought to social and environmental consequences. Many multinational corporations (MNCs) based in developed countries and other reputation-sensitive companies have begun to learn hard lessons from applying this approach and are now moving beyond the rule that only a single bottom line—profits—counts.

While not denying that regulations need to be more vigorously enforced by public authorities, this report shows that there is another way of thinking about environmental protection that puts a much greater emphasis on a new role for the private sector—one in which it accepts a greater degree of responsibility and accountability for environmental performance. This new role holds tremendous promise, but it also runs counter to the prevailing business climate in Asia and the Pacific.

Economists and business managers have tended to view profitability and environmental protection as being in conflict. The predominant economic paradigm is that the purpose of a firm is to maximize profits for its shareholders, and for some, this is the only moral imperative for corporations.[14] In many respects, profit maximization can be thought of as a legal or fiduciary responsibility. Corporations have a legal obligation in many countries as a "person" in the eyes of the law to make profits for shareholders. Management theorists extend this "profit-centric" view to argue that the corporation is merely the sum of the property rights of individual shareholders with economic returns the only objective yardstick of achievement.[15]

Within this framework, corporations only undertake environmental management initiatives because the law requires them to. It is accepted that governments have a role to play in protecting environmental quality because a range of market imperfections place such concerns outside of the private profit calculations, with the costs borne by society. Profit-centrism concludes that when these market failings are discovered, efficient governments will correct them by implementing laws that require businesses to internalize environmental costs (the "polluter pays" principle).

According to this way of thinking, any environmental improvement initiatives taken beyond a minimum level of legal compliance are purely voluntary and are the result of ethically determined behavior of firms driven by concerns other than an economic imperative. Following this model, there will always be tension between the demands of profit centrism and ethical stances that might cause businesses to perform at a "beyond-compliance" level. Particularly in developing countries, an ethical stance toward the environment may be seen as an unaffordable luxury because it will sacrifice competitive advantage.

This traditional tension, however, holds true only if several conditions are met. For example, if consumer demand is not static but moves toward a more environmentally sound set of preferences, then the early business mover may actually capture increased market share. It also assumes that new technologies will not couple increased economic efficiency with lower pollution and that customers, governments, and other civil society stakeholders do not care enough about the environmental management approaches of specific businesses to take actions that will drive up other operation costs or reduce demand for a company's products. The static nature of the "profit maximization versus beyond-compliance environmental improvement" argument has been challenged in recent years.[16] There is now ample evidence, some of it from Asia, that many clever corporations have been able to improve their environmental performance while simultaneously increasing economic performance.[17]

THE BUSINESS CASE AND OTHER MOTIVATIONS FOR CORPORATE GREENING

There is widespread evidence of modern corporations radically adjusting their environmental behaviors. While the "greening of the corporation" is still quite new, there is enough evidence available to draw some general conclusions about what is motivating many contemporary businesses to adopt a greater degree of environmental responsibility.

Before this can be explored, however, it is worth examining what it means if a corporation is "green" or environmentally responsible. This is not a simple question. Take, for example, the following situations.

- Is a recycling plant that emits air pollution a "green company"?
- Is an aluminum smelter that dramatically reduces its air pollution or waste sent to landfill but that contributes large emissions of GHGs a producer of "green jobs"?
- Are all jobs associated with the ecotourism industry "green"?

The simplest definition of a "green" corporate initiative may be one that reduces the negative impact made by a company on the environment. This broad definition would allow corporate greening to be thought of as occurring across a spectrum, from innovations that reduce the environmental impact of traditionally dirty industries (such as steel manufacturers) to those that have been instigated specifically to develop and market green products or to provide solutions to environmental problems.

Where in a corporation such "greening" occurs depends on the nature of the firm's business. Primary producers can make environmental improvements in the way they grow and harvest a product and prepare it for further processing or final market.

Manufacturers can become greener by making changes in their production processes and/or by deciding to make and sell "environmental" products. Service providers have less choice, having to focus predominantly on the environmental impact of their workforces, buildings, and infrastructure (though where services substitute for goods, this also tends to result in reduced environmental impact).

So, does it pay to be green? Many studies have focused on the link between public disclosure of environmental performance and share prices.[18] Overall, the answer has been positive, but business' response to these findings has been somewhat skeptical, perhaps because managers understand clearly that green business decisions only sometimes result in increased profits.[19]

Naturally, business managers have a direct economic incentive to make environmental investments where they deliver positive returns or reduce significant risks, and there are many circumstances in which addressing environmental problems can result in profitable outcomes.[20] Several approaches can be taken to better integrate environmental considerations into business strategies; this report will explore these in greater detail in later chapters.

Corporations also can differentiate themselves by creating products or processes that offer greater environmental benefits or smaller environmental costs than those of their competitors. Chapter 5 presents a selection of the kinds of business opportunities that are opening up in a number of environmental industry sectors.[21] Recent research into environmentally benign manufacturing has shown growing interest from firms from Asia and the Pacific in using the environmental advantages of their products and processes to enhance their competitive positions in the market.[22]

The simplist strategy focuses on internal cost cutting. Corporations can often find cost savings through more efficient use of inventory and through waste minimization, recycling, and reuse. This eco-efficiency strategy is discussed in Chapter 5.

A third method by which corporations can simultaneously derive environmental and business benefits is by changing the rules of the game—pushing for private standards or for new government regulations that favor particular corporate operations. Private standards are developed when corporations in a similar industrial sector band together to establish tougher environmental performance conditions (by way of a voluntary code). This is sometimes driven by an environmental disaster; a typical example is the chemical industry's response to the Bhopal methyl isocyanate catastrophe in India in 1984 (which resulted in that industry's voluntary responsible care program). Companies that participate in such programs gain competitive advantage over nonparticipants by creating a cleaner image and reducing risks and compliance costs. With this strategy, environmental costs often increase but at a rate that is slower than for nonparticipating competitors. Establishing voluntary industry standards is a booming component of the "new regulatory approaches" discussed in more detail in Chapter 4.

Costs also can be reduced through risk reduction; this is the focus of the fourth approach to integrating the environment into business thinking. Accidents, consumer boycotts, and environmental lawsuits can be extremely costly. Avoiding them by investing in better risk management measures is another source of competitive advantage. The issue of environmental risk reduction, especially as it relates to consumer preferences, is discussed in Chapter 2, but it also has relevance to the technology choices discussed in Chapters 6.

Many pressures influence whether a corporation will become greener. Businesses can be attracted by the "pull" of the market. They may also, however, be influenced by the "push" of a range of external drivers and by the internal characteristics of firms themselves. It has only been in recent years that these kinds of push pressures have begun to have an impact on businesses in Asia and the Pacific. To date, the main concern of environmental regulators in the region has been to either encourage or force corporations to move toward a basic level of compliance with traditional environmental regulations, often adapted from developed countries. Chapters 2 and 3 outline the range of international and national pressures beginning to impinge on corporations in Asia and the Pacific and their freedom to operate. The combination of these pressures will force them to move quickly toward compliance—and hopefully beyond—using the sustainability tools outlined in Chapter 4.

Generally, traditional command-and-control regulatory approaches where governments set technology standards or strict enterprise-based emission limits, have met with mixed results. The evidence from developed countries appears to show that traditional command-and-control regulations can initially be effective in bringing firms up to a minimum level of compliance, which is why we believe they remain an essential part of the role of governments in Asia and the Pacific. However, as institutions mature and regulations become more versatile and better enforced, their effectiveness appears to diminish.[23]

Differences in compliance rates can be accounted for by the complex interaction between external factors (such as tightening regulations, pressures from civil society stakeholders, and the political culture of the countries within which corporations operate) and internal factors (such as organizational culture, organizational learning styles, and the influence of individual employees). Until recently, it was thought that external drivers, especially regulators and civil society stakeholders, had the strongest influence on the environmental performance of corporations.[24] While these are still considered to be important, new research is starting to show that internal drivers (especially organizational culture) can play an equally important role.[25] The complexities of these interactions are evident in cross-national research which indicates that in some countries in Asia and the Pacific, firms are mainly responsive to "best practices" endorsed by regulatory agencies whereas in others, firms are more sensitive to the influences of their trade associations.[26]

It is becoming clear that corporations—especially the larger ones with international markets—are beginning to think of their "licenses to operate" as going beyond the traditional regulatory license. The report deals with this important concept in more detail in Chapter 3.

THE PURPOSE OF *ASIAN ENVIRONMENT OUTLOOK 2005*

This is the second *Asian Environment Outlook* (AEO) report prepared by the Asian Development Bank (ADB). AEO 2001 was the first in a series of periodic reviews of environmental and developmental trends and policies in ADB's developing member countries to identify opportunities for them to better achieve their stated environmental objectives. The primary audiences for AEO 2001 were seen as decision makers in those governments and planners as well as specialists from international assistance agencies. They were expected to use the report in formulating environmentally sound development policies and programs with a focus on mainstreaming environmental concerns across and within economic sectors into all levels of development policies and plans.

The conventional approach to the problem of environmental degradation in Asia and the Pacific has been to focus almost entirely on the role of governments. The underlying assumption has been that if the correct mix of policies and institutional resources is obtained, then better environmental outcomes will be the result. While it is undoubtedly true that governments must continue to play a central role in maintaining environmental quality, it

is also clear that this traditional focus diverts attention from the most active financier and player in the development equation—the corporate sector. While governments determine the rules under which businesses act, it is the firms themselves that use natural resources, make products, and generate pollution. In this second AEO report, attention turns to the role of the corporate sector in environmental management in Asia and the Pacific. A globally sustainable future is not possible without the active involvement of corporations in the region. This is good business news for proactive firms that are not only willing to go beyond compliance but that also actively seek new business models and opportunities from the environmental investment backlog that faces the region as well as growing demand for environmentally friendly goods and services.

AEO 2005 has been written with a number of audiences in mind. The primary target group comprises the management, owners, employees, and stockholders of corporations operating in Asia and the Pacific. The report illustrates why there is a crucial role for them to play in regional environmental improvement. The drivers for improved environmental performance and the benefits to be derived are highlighted. For both public and private sector audiences, examples are provided of new ways of thinking about regulation and incentives that put more emphasis on corporations as engaged and responsible actors. Taking greater responsibility for the environmental consequences of their behavior may lead corporations to think more widely about their relationships with a range of stakeholders and to investigate what new environmental markets might look like. Although all kinds of businesses are targeted—multinational subsidiaries, large and small local firms, state-owned corporations, cooperatives, publicly traded firms, and privately owned operations—it is acknowledged that the corporate audience will consist predominantly of larger companies. For the vast number of small and medium enterprises (SMEs) in Asia and the Pacific that are part of a supply chain providing inputs to large (and especially export-oriented) corporations, peer-to-peer communication will be needed to convey the message.

Reaching SMEs outside such global supply chains remains a challenge but may be approached through industry associations that have outreach programs that serve the interests of constituent corporations. Unfortunately, most SMEs are not usually aligned with an industry association nor do most associations have adequate resources to actively seek out the SMEs in their sectors. The report provides examples of how industry associations around the world have become active players in new regulatory initiatives and how their involvement might result in better environmental outcomes for the industrial sectors that they represent. This report should provide industry associations a ready compendium of information in a form that can be conveyed to their members and perhaps encourage them to develop more extensive outreach programs to SMEs. Governments can also learn how they might best reach this SME audience.

Despite primary focus on a corporate audience, effective corporate environmental responsibility cannot take place in a policy vacuum. For officials of governments in the developing countries of Asia and the Pacific, the report outlines policy benefits in corporations taking greater responsibility for their own environmental performances. Evidence is presented that the "new" approaches to regulation have achieved better environmental and broader development outcomes. The role of governments in institutionalizing more effective corporate environmental performance and creating a strong enabling environment is explored.

Multilateral agencies assist national governments in Asia and the Pacific in dealing with environmental problems. The report also examines how multilateral agencies can best assist national governments to enable the uptake of corporate environmental responsibility concepts. Finally, one of the most important audiences for the report is civil society stakeholders. Civil society is interested in (i) whether corporate environmental responsibility initiatives can be proven to result in better environmental outcomes; (ii) how it might be possible to avoid "greenwash" through proper scrutiny of business use of the new regulatory tools; and (iii) how nongovernment organizations (NGOs) and other civil society stakeholders can participate in productive partnerships with corporations but still maintain their autonomy and ability to apply external pressure.

There has been no shortage of attention to environmental issues both globally and regionally since the release of AEO 2001. National and regional priorities, goals, and objectives are clearer. New laws, regulations and standards have been promulgated, although enforcement needs to be improved. There are some scattered examples of increased state expenditure on the environment and of more effective performance. Several new national councils for sustainable development have been created, and new institutions are planned. Nevertheless, as routinely reported in various national and subregional state-of-the-environment reports, generally speaking, environmental conditions throughout the region have continued to deteriorate. No country could yet claim to be on a path to sustainable development.

This report contends that one of the most vital missing ingredients in Asia and the Pacific is a fully engaged corporate sector committed to environmentally sound and sustainable production and consumption. The key role of the corporate sector is universally acknowledged, but concerted corporate sector engagement in these global processes has yet to be fully developed in the region.

A GUIDE TO READERS OF *ASIAN ENVIRONMENT OUTLOOK 2005*

Across the planet, the private sector is expected to do more to pursue the goals and objectives of sustainable development. **Chapter 2** outlines the emerging pressures coming from external forces that companies in Asia and the Pacific can no longer ignore. Commercial banks, stock exchanges, and insurance companies require borrowers to demonstrate environmental commitment. Chambers of commerce are embracing charters of sustainable development, and public-private partnerships are being formed to achieve environmental objectives. Global environmental performance standards are becoming a badge of good corporate governance and are being passed on to SMEs through supply-chain relationships. Consumers demand evidence that goods were produced in a sustainable manner and are prepared to boycott companies suspected of ignoring environmental and labor laws. Environmentally and socially responsible investment funds exclude poor environmental performers and reward "green" companies. Anti-globalization activists armed with modern communication technologies are demanding greater accountability. Corporate annual reports are expected to cover social and environmental performance. Stockholder advocates are pushing wide-ranging resolutions at annual meetings. So far, much of this pressure has emphasized voluntary commitment, but the trend is inexorably toward more mandatory requirements. Companies in Asia and the Pacific will be gradually, but surely, caught up in these worldwide trends.

For the companies that recognize this worldwide trend and are prepared to move toward compliance with environmental regulations and standards, they face a formidable and often confusing range of

existing and developing plans, regulations, and standards at the national level. These are emanating from commitments of their governments to global standards and treaties; from national governments formulating strategic plans and regulations; from subnational and sector policies; and from industry-led "new regulation" benchmarks, codes, and partnerships. **Chapter 3** outlines the key types of regulation and standards that compliant companies in Asia and the Pacific will need to consider, both extant and emerging, in line with developing regulations in the Organisation for Economic Co-Operation and Development (OECD) and elsewhere. It also examines the relatively new set of regulations and quasi-standards emerging from public-private partnerships and voluntary agreements and how to negotiate with partners who were previously viewed as "enemies."

Once the inexorable global trends are realized and the corporation has identified how to distinguish between "hard" and "soft" standards in the national landscape, the question remains how to implement changes within the corporation that will lead toward, and hopefully beyond, compliance. **Chapter 4** examines the emerging toolkit of internal change processes comprising environmental management systems (such as the International Organization for Standardization's [ISO] 14001), environmental auditing, environmental reporting, and internal management changes to ensure that these tools are mainstreamed into the business and are not public relations add-ons. Although many of these tools were developed in OECD countries, they can (and often must be) adapted to different cultural and environmental conditions in Asia and the Pacific. Changes in organizational culture are often the key to ensuring that internal change processes promoting improved environmental performance take root; the latest thinking about this challenge is included.

Fear of a business threat from these changes is not an ideal motivator for corporations. A more powerful motivator is that addressing environmental problems can lead to profitable outcomes. **Chapter 5** outlines how these opportunities might present themselves for businesses that are prepared to go "beyond compliance" and seek new opportunities either through eco-efficiency in their existing business lines or through engagement in new business opportunities such as servicing the massive backlog of environmental infrastructure or operating in the environmental goods and services sector. Millions of new jobs are being created in the environmental goods and services industry although companies in the region have generally been slow to capitalize on them.

Despite recognizing these global trends, some laggard firms in Asia and the Pacific may still believe that there is no need to move toward or beyond compliance because new technologies are coming along that will make the environmental concerns of the past few decades obsolete. **Chapter 6** addresses the ability of the "techno-fix" to bring in a golden era of sustainability. Eight strategic fields spanning current scientific and technological innovation are examined and their likely contribution to future economic growth is postulated. New technologies such as nanotechnology and biotechnology may offer the promise of making some of our current environmental concerns largely obsolete as well as opening up new green business opportunities. However, they could also make many old-style businesses in the region equally obsolete. Information technologies and the phenomenal growth of e-business, tailoring production to precise consumer demands, and just-in-time production systems may make the old hierarchical corporations extinct. The business community in the region dominated as it is by family-owned firms, state-owned enterprises, and SMEs needs to be aware of these trends, participate in finding solutions to environmental problems, and be ready to adopt new opportunities. Blissful ignorance is no longer an option.

All technologies extend the power of humans to do more, go faster, and live more interesting lives than our puny bodies would have allowed our caveman ancestors. Unfortunately, all technologies can be used for both good and evil. Nuclear energy might light the cities of France, but technology unleashing the power of the atom could also wipe out humankind in a nuclear holocaust. Chapter 6 also addresses this dual-edged nature of the emerging technologies and what safeguards might need to be put in place to ensure that they actually contribute to environmental solutions rather than add to the burden on the planet. It also highlights the potential new environmental dangers that such technologies may bring and the lack of preparedness to deal with such dangers in Asia and the Pacific.

Finally, in **Chapter 7**, the report outlines how governments and other institutional actors in Asia and the Pacific need to create an enabling environment that will allow firms in the region to leapfrog over outmoded policy approaches and technologies. The chapter conveys the messages heard from the corporate sector—through workshops and reviews of draft versions of AEO 2005—on the assistance and incentives they expect from policy makers if they are to play their parts in achieving sustainable development. This final chapter reminds the region's institutions and decision makers that global sustainability depends on what happens in Asia and the Pacific over the next 20 to 50 years. If this region cannot achieve sustainability, then the rest of the world cannot compensate for its failure.

CHAPTER 2

Growing Pressures for Corporate Environmental Responsibility

Emerging changes in the structure of the increasingly globalized economy are leading to enhanced environmental awareness and a shift in expectations regarding both public and private environmental management. Mostly generated by powerful forces outside Asia and the Pacific, these are now strongly affecting business leaders, government officials, and civil society. Demand for improved environmental performance will, however, be felt most acutely by the business community. Those business leaders who prepare their companies now to accommodate these social and market forces will prosper; they will profit from being environmentally proactive and will capture increased market share. Those who ignore these challenges will suffer and may even see their survival threatened. The purpose of this chapter is to describe the external pressures that will challenge the private sector to change the way it does business with regard to environmental management in Asia and the Pacific. Before examining these pressures, however, it is necessary to provide some historical perspective.

THE EVOLUTION OF SUSTAINABLE DEVELOPMENT

Protecting the environment is not a new phenomenon, at least not in the developed world. Most OECD members began to take formal action to improve environmental quality beginning in the 1960s. During the post World War II era, there was a burst of economic activity built on huge demand for a wide range of consumer goods—automobiles, housing, appliances—all of which required more energy and raw materials. A rapid expansion of households accompanied the postwar baby boom, and the war-ravaged economies of Europe and Japan were rebuilt.[27] This increased economic activity was accompanied by an unprecedented amount of industrial pollution and unwanted waste. Pea soup smog from coal combustion and diesel engines killed 12,000 people in London in 1952.[28] Smog emanating from automobile emissions blanketed Los Angeles and other cities of North America. Lakes and rivers were dying as untreated wastes poured into them. Oil spills at sea resulted in beaches and wildlife coated with black tar. People all over the globe—especially those in the Pacific—were concerned over nuclear fallout from atomic bomb testing in the atmosphere. Pesticides and other poisons were showing up in areas far removed from where they had been applied. The emerging connection between pollution and public health was the primary driver of this phase of the environmental attention cycle, but increased leisure time and the need to preserve open spaces were also significant.[29]

As the per capita income of citizens in Europe, Japan, and North America rose and the environmental damage became increasingly visible and publicized, the affluent middle class began to demand improvements in environmental quality. Initially, most business leaders appeared hesitant to respond to these demands. Political

leaders did, however, react to grassroots pressure and began to enact a new body of environmental laws and regulations. This was the genesis of the "command-and-control" environmental model that dominated the first decades of the modern environmental movement. It was characterized by government regulations that dictated acceptable pollution control technologies for all types of production. These regulations mostly imposed retrofits of existing plants though "end-of-pipe" or "top-of-stack" solutions.

From a corporate viewpoint, this retrofitting was all cost and no benefit. The more stringent the regulation, the higher was the incremental cost of compliance. In the worst cases, factories were closed without regard to employment or economic considerations. Often this process led to bitter political and legal confrontations between business and environmental advocates with governments forced to make difficult choices.

By the mid-1980s, policies and environmental programs in Europe and North America began to enter a second phase. Greater attention was given to invisible or hidden pollutants and to new sources of future pollution. The concept of pollution prevention entered the lexicon and debate over environmental policy. Environmental legislation such as the Clean Air Act in the US moved away from strict technology-driven regulations toward more flexible approaches allowing corporate innovation to achieve agreed environmental quality standards. Innovative entrepreneurs began to change their core production processes and to integrate environmental considerations into the design of new facilities. Cleaner production methods reduced pollution levels per unit of output often at a cost far lower than controls tacked on at the end of the process. This gave some firms a competitive advantage over those continuing to use dirty technology and contributed to a "greener image" for such innovators. In Asia and the Pacific, growth was beginning to pick up as the Southeast Asian "tigers" expanded their export-oriented manufacturing capacity, the PRC opened its economy to the outside world, and India started to move away from its self-reliance model of development. In most developing countries, however, environmental degradation was still viewed either as an inevitable consequence of rapid economic development or as a phase to be endured that developed countries had also passed through on their way to prosperity.

In 1987, the World Commission on Environment and Development issued its landmark report that introduced the concept of sustainable development and recognized a need for business to make radical changes in the way it operated to meet the demands of growing populations for more goods and services. This blue-ribbon panel report signaled the importance of poverty alleviation as integral to preventing unsustainable use of the world's resources and natural ecosystems. The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 acknowledged this new direction, but it did not fully embrace the concept of sustainable development. In the decade between UNCED to the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, the policy, academic, and business communities began to flesh out the concept of sustainable development as resting on three "pillars" or measures of performance: (i) economic, (ii) environmental, and (iii) social. For most developing countries in Asia and the Pacific, economic growth remained paramount, and lip service paid to environmental and social goals was not backed with adequate resources.

By the time of the WSSD meeting, environmental policies and programs in the OECD countries had begun to enter a third phase. This partly reflected a co-evolution of environmental policies and business practices as manufacturers turned to smaller, lighter, safer, and more environmentally benign products. The emerging new paradigm was to create more value with lower risk and lower impact on nature with entrepreneurs beginning to focus on delivering services rather than products. At the same time, a growing share of the "West's" production (and increasingly its service sector) was being outsourced to newly industrializing countries—especially in Asia and the Pacific—as a part of the globalization phenomenon. Companies began to take into consideration the entire "life cycle" impacts of their products from "cradle to grave." Further, there was greater recognition that the poor were often the main victims of environmental degradation as poverty itself also could be an enemy of the environment. There was a new realization by most that society could not succeed in achieving its environmental or societal goals unless the business community was involved as an active partner with governments and the various elements of civil society.

This evolution of sustainable development thinking was mirrored within the business codes and practices of progressive companies. A Norwegian company describes the evolution of its own environmental and sustainability improvements in four phases: (i) the repair phase, and "cleaning up its sins of the past;" (ii) the preventive phase—developing and installing cleaner technology; (iii) the business development phase—minimizing environmental impacts of products throughout their entire life cycle; and (iv) addressing globalization issues that affected their business.[30]

Outside of Japan, the Republic of Korea, and Singapore, environmental consciousness developed much later in Asia and the Pacific than in Europe and North America. For example, the PRC's leaders attributed the environmental problems of the developed world in the 1960s to the evils of capitalism. However, central planning and dispersion of industry for security reasons in the PRC also proved disastrous for the environment as unrealistic production targets dictated from Beijing had to be achieved by local communes regardless of the environmental costs. Deserts expanded due to unrealistic yield expectations from agriculture and from settling of nomadic livestock herders into permanent villages. Self-sufficiency in the communes meant that inefficient production systems such as backyard iron and steel smelting and a myriad of highly polluting township and village enterprises destroyed surrounding forests and turned streams into black, foaming, lifeless bodies of water. As the state owned the means of production and cared little for noneconomic measures of living standards, there was little incentive for the government to impose costly environmental controls. It was not until 1992 that the ruling Communist Party in the PRC formally replaced central planning with a socialist market economy. In 1997, the 15th National Congress upgraded the private sector from a necessary supplement to the public sector to an important component of that economy. By 1999, only 28% of gross industrial output was from state-owned enterprises.

The earliest environmental body in the PRC was the Leading Group for Reutilization of Three Wastes (wastewater, gas, and solid wastes) established in 1971 under the state planning commission. The first national environmental conference was held in 1973 and resulted in a regulation to protect and improve the environment. A trial version of an environment protection law was adopted in 1979 and was replaced by a new version in 1989 that stressed effluent fees and emission permits. The National Environment Protection Agency was established in 1984 and elevated to a ministerial-level organization and renamed State Environment Protection Agency (SEPA) in 1998. Each province now has a Provincial Environment Protection Board. By the late 1980s, the disastrous state of the PRC's environment was increasingly obvious. In 1993, the National People's Congress established the Standing Committee on Environment and Resource Conservation to review the drafts of the numerous environmental laws that have been promulgated over the past decade and to recommend improvements. Following developed country examples, the PRC initially opted for command-and-control regulations and end-of-pipe solutions. Gradually, highly polluting, inefficient enterprises have been shut down, but the growth of the economy has been so rapid that total pollutant loads have continued to grow. Despite an impressive array of environmental laws and regulations, enforcement remains weak.[31]

Box 1: Corporate Environmental Performance and Competitiveness in Asia

A report published by the Corporate Environmental Governance Program of the University of Hong Kong offers some interesting observations suggesting that countries across the region should be paying more attention to how their companies perform environmentally. A survey of 450 companies from 15 countries posed 25 questions about the environment, corporate social responsibility, labor standards and human rights, sustainable development, and perceptions about the future. Responses were used to generate a Business Sustainable Development Preparedness Index for each country and then to consider whether there are links between this index and competitiveness at the country level by reference to the World Economic Forum Business Competitiveness Ranking.

While a direct causal relationship was not established, the results suggest that countries with companies most prepared for sustainable development tend also to be the most internationally competitive. The report grouped countries into two categories. Group one contains those that achieve both a high Business Sustainable Development Preparedness Index rating and at the same time are ranked relatively highly in Business Competitiveness. These countries seem to be leading the way in terms of business and sustainable development. Group two includes those countries that scored less well in the Business Sustainable Development Preparedness Index and typically have lower rankings in Business Competitiveness.

From Asia and the Pacific, the former group includes Singapore and Japan, while the latter group includes the Republic of Korea, Malaysia, Thailand, and Hong Kong, China. From these results, then, it appears that a credible business case can be made for attention to sustainable development issues due to links with overall competitiveness.

Despite this relationship, the results of the report suggest that companies from the region still need convincing that sustainable development concerns are in their best business interests. While companies from Asia and the Pacific surveyed perceived that environmental deterioration will be a bigger issue over the next five years than their North American and European counterparts, the region's companies were relatively less convinced that sound environmental and social responsibility practices will be a source of competitive advantage in the future.

Source: Welford, Richard. 2004. *The Business Sustainable Development Preparedness Index and Country Competitiveness: An International Comparison*. Hong Kong. The Centre of Urban Planning and Environmental Management, The University of Hong Kong.

Despite limited, recent improvements, it is clear from regular state-of-the-environment reports that the rapidly growing economies in Asia and the Pacific, especially the PRC and India, are still lagging behind the rest of the world and need to act on environmental issues now. This report argues that the longer the region's societies defer action, the more expensive it will become to clean up the mess. An ounce of environmental prevention now will reduce the ultimate bill for cleaning up. In the interim, millions of individuals will suffer from unhealthy air, dirty water, toxic dumps in their neighborhoods, and seriously degraded ecosystems that may be irrevocably damaged or may require decades to recover from present abuse. There is a clear economic and moral case for acting now. But that may not be sufficient to get the attention of business! In fact, a recent study showed that many companies from the region still need convincing that sustainable development concerns are in their best business interests (see Box 1). Perhaps the strategic threat to business from looming pressures generated from outside the region will call them to action.

THE EXTERNAL PRESSURES

There are five primary driving forces behind the sweeping economic changes blowing over Asia and the Pacific:

- entry into the global economy;
- the emergence of an affluent, consumer-oriented middle class;
- the information revolution;
- urbanization; and
- industrialization.

Entry into the global economy, on balance, appears to be a force encouraging a "race to the top" rather than the feared "race to the bottom" in terms of production practices, including their environmental dimensions. When major retailers in the West place an order for a million small electrical appliances, they impose a host of labor, environmental, and other requirements on the supplier. The wiring must be safe and meet well-established standards. The buyer insists on product quality control. The number of defective products reaching consumers must be minimized or the profitability of the entire venture can be destroyed. The normal requirement is at least compliance with ISO-9000 total quality control or similar standards. This forces companies in Asia and the Pacific to carefully measure and monitor their performances, and "what gets measured gets managed"! As soon as plant engineers, product designers, and managers begin to measure production processes more carefully, they begin to identify waste and eliminate pollution. During bidding, purchasers often inspect the production facilities of competing firms. Firms that pose higher risks of fire or other accidents are downgraded. The purchaser wants to minimize all potential disruption to the timely delivery of goods during key sale periods. Just-in-time delivery and dependable supply is crucial to winning and maintaining contracts in the 21st century. Thus, entering into global markets can be a force for improved health, safety, and environmental performance.

The ***emergence of an affluent middle class*** in the region may ultimately yield a net gain for the environment—balancing increasing resource use against demand for environmental quality improvement. Upwardly mobile consumers demand more goods and services, and this obviously places increased pressure on natural resources and waste sinks. The rise in the world price of oil, largely fueled by increased demand in the PRC, is one example of how increasing consumption impacts natural resources and prices. These more affluent consumers may also become a force for improved environmental performance, subject to some lags in response. Affluent consumers have market power, and they will demand improved quality of life as well as increased quantity of goods. Given appropriate information, affluent consumers will not buy shoddy goods or those associated with unacceptable levels of pollution, poor labor standards, and degradation of the natural environment. Their demand for more goods and services is inevitable so the hope must be that demand for improved environmental quality "kicks in" fast enough to send unambiguous signals to both business and government leaders.

The ***information revolution*** enables a more open and transparent society. In a world of satellite TV, Internet access, and ubiquitous cell phones (many with cameras), it is increasingly hard for any business or government to hide from public scrutiny. Make a serious mistake and the local community knows about the problem instantaneously. Courtesy of 24-hour news stations, the entire world will know about it tomorrow. Firms dumping toxic waste into rivers and streams can be exposed through photographic images of their asocial behavior on the Internet; consumer boycotts damaging corporate reputation and profitability surely will follow. Companies are learning quickly that in the always-on news world, reputations can be damaged easily and/or permanently. Thus, the information revolution—especially when combined with the emergence of an affluent, more assertive middle class—is a potentially potent force for improved environmental performance. On the negative side, advertising pays for much of the always-on media coverage and often cleverly exploits the seductive power of conspicuous consumption which (if unchecked) can tip the balance of choice away from the better environmental alternative.

The global trend toward ***urbanization*** is relentless and it is strongest in Asia and the Pacific. Currently, about 1.56 billion people live in the region's urban areas, and

this is projected to grow to 2.21 billion by 2020.[32] Why do people move to crowded urban centers? One reason is the expectation of an improved quality of life. Urban areas are hives of economic activity, opportunity, and creativity. There is a higher probability that essential services like water, sanitation, and electricity will be available in these areas. In many rural areas, comparable services are not available at any price. Cities also generate huge pollution loads from municipal waste, transport, and industry. Urbanization may become a force for improved environmental performance if city dwellers demand environmental quality as part of their collective aspirations and are willing to pay for it through the tax base. The phenomenon also places enormous responsibilities on local and national governments to ensure that the demands for common services are reliably provided at a reasonable cost. Crowded populations in slums without these basic services are, of course, environmental nightmares. Far too many people in Asia and the Pacific are forced to live in such unsanitary conditions with chronic and epidemic diseases often the result. If the pace of urbanization exceeds the capacity to upgrade and install new urban environmental infrastructure, the urban environment will continue to degrade.

Industrialization is the fifth driving force that is changing the face of Asia and the Pacific. The region's share of global output, for example, was roughly 10% in 1950, 30% in 1995, and is expected to reach 55–60% by 2025.[33] Population is shifting from rural areas to urban areas and is creating a new workforce to power this process. The collective impacts of their industrialization probably will not benefit the environment in the short term. Increased production is placing great pressure on natural resources, and where it is based on older polluting technology, the impacts are definitely negative. However, rapid expansion of the industrial base of the region requires massive new capital formation and provides unique opportunities to turn over the old capital stock quickly and phase out polluting technology. If the existing capital stock is largely replaced with new, cleaner technology, then pollution levels per unit of output can actually be reduced as industrial production levels increase. Consultations with business and academic leaders from the region indicated that MNCs are transferring world-class technologies to Asia, often at a much faster rate than they can turn over the old capital stock in Europe or North America. It is crucial that per-unit pollution intensity declines quickly in the region, because the collective economic product is growing so rapidly.

The combined environmental outcome of these five driving forces in Asia and the Pacific remains uncertain. It will be determined in each country by a complex balancing of (i) supply chain pressures versus the temptation to take advantage of still lax environmental controls; (ii) a demand for quality of life by an emerging middle class versus the desire for conspicuous consumption; (iii) information on environmental degradation associated with consumption versus information inducing increased consumption (iv) the pace of investment in urban environmental infrastructure versus the pace of urbanization; and (v) the pace of capital stock replacement with clean technology versus increased industrial output.

These driving forces have found their expression in recent times in a range of specific "demands" emanating either from consumers or from global policy and standard-setting organizations. The remainder of this chapter presents the most significant of these new expectations.

Global Compact

The Secretary-General of the UN has called for "Globalization with a Human Face." At the 1999 World Economic Forum in Davos, Switzerland, he proposed the creation of a "global compact"—a voluntary initiative intended to bring private companies together with UN agencies, labor, and civil society to contribute to poverty alleviation. By September 2005, more than 2,400 organizations and nearly 50 country networks around the world had signed on. To join the initiative, companies are required to follow 10 principles in the areas of human rights, labor, anti-corruption, and the environment.

The Global Compact generally draws its environmental principles from the 1992 Rio Declaration on Environment and Development which contained 27 principles defining the rights of people to development and their responsibilities to protect the common environment. This explains the wider context of the three environmental principles of the compact: (i) to support a precautionary approach to environmental challenges, (ii) to undertake initiatives to promote greater environmental responsibility, and (iii) to encourage the development and diffusion of environmentally friendly technologies. According to Agenda 21, the broad policy statement that emerged from the UNCED conference, greater environmental responsibility means, "…responsible and ethical management of products and processes from the point of view of health, safety, and environmental aspects. Toward this end, business and industry should increase self-regulation, guided by appropriate codes, charters, and initiatives integrated into all elements of business planning and decision-making, and fostering openness and dialogue with employees and the public." In addition to applying this precautionary approach, corporations are encouraged to (i) adopt the same operating standards regardless of their global location, (ii) ensure these standards are followed by all suppliers through supply-chain management, (iii) facilitate technology transfer from the developed to the developing world, (iv) build environmental awareness in company locations, (v) communicate with local stakeholders, and (vi) share benefits equitably. Compliance with Global Compact principles means that companies are meeting these Agenda 21 objectives.

The precautionary principle has been subject to considerable controversy. Some view it as an excuse to delay all economic expansion by those who prefer the status quo to a future that will pose greater risks to society and the biosphere. Its proponents argue that it is unacceptable to give industry or anyone else a blank check and impose unacceptable risks on society. Where precaution is a fundamental strategic concern, corporations can (i) build in safety margins, (ii) ban or restrict activities with uncertain impacts, (iii) adopt best available technology, (iv) implement cleaner production and industrial ecology approaches, and/or (v) communicate their concerns to stakeholders. Common sense argues for environmental impact assessments (EIAs) or strategic environmental assessments for major new initiatives and for the introduction of radical new technology. It would, however, be equally foolish to allow the precautionary principle to become a bureaucratic barrier to the introduction of new cleaner technology or other environmental management innovations.

Moving toward environmentally sound practices and technologies may involve corporations in (i) changing their processes or manufacturing techniques, (ii) changing to environmentally benign and/or less toxic input materials, (iii) making changes to their products, or (iv) reusing materials on site by recovering useful materials from waste. Life cycle analysis/assessment (LCA) and other well-established techniques may help to identify appropriate technologies.

Half of the companies participating in the Global Compact say they have changed their policies as a result. For nearly two thirds of companies from developing countries, the compact is their first corporate citizenship initiative, often entered into to gain supplier relationships with larger global firms. More than 100 partnership programs have been undertaken thus far in support of the Compact's principles. The UN is now examining how to market compliance with the Global Compact as an identifiable seal of good governance and to ensure that there are no free riders.

Some NGOs have expressed discomfort that the UN and its Global Compact is in

danger of "getting too cozy" with the business community. This reflects latent distrust between the environmental and business communities that is partly a legacy of confrontational battles during the first and second phase of the modern environmental movement. The current phase involves greater use of partnerships and the aligning of environmental and economic goals.

Sustainable Production and Consumption

One of the most contentious and poorly understood areas in the debate over sustainable development relates to the concept of sustainable consumption. The business community remains solidly wedded to providing maximum consumer choice through open markets. Some environmental NGOs prefer government intervention through punitive taxes and charges to curtail excessive consumption patterns that damage the environment. A growing number of customers state outright that they only want products that help or are at least neutral toward the environment, and many say that they want to do more with less and want life to be simpler and less wasteful. Such consumer motivations provide a strong rationale for corporate eco-efficiency and the marketing of "green" products.

It is axiomatic that human populations cannot expand indefinitely with everyone expecting to live at the current levels of consumption and production in developed countries. Human activity already takes up 83% of the Earth's land surface for settlement, farming, mining, or fishing.[34] We also use 98% of the land suitable for farming our major staple crops of rice, wheat, and corn. In addition, we have appropriated 40% of the net primary productivity, 35% of the productivity of the oceanic shelf, and 60% of freshwater runoff.[35] Highly subsidized farmers in Europe and North America, however, may question any such physical resource constraints, as they may even be paid not to farm. There is uniform agreement, however, that doubling human population density is not possible without greatly increased efficiency in resource use, radically improved production technology, reduced consumption, reduced space for all other living things, or some combination of these factors.

In 2001, the World Business Council for Sustainable Development (WBCSD) issued a report entitled *Sustainability Through the Market—Seven Keys to Success,* which was to provide a business perspective on this contentious issue.[36] The seven recommendations were:

(i) innovate;
(ii) practice eco-efficiency (or cleaner production);
(iii) move from stakeholder dialogues to partnerships for progress;
(iv) provide and inform consumer choice;
(v) improve market framework conditions;
(vi) establish the worth of Earth; and
(vii) make the market work for everyone.

Governments, environmental NGOs, and businesses can all agree with these keys. The main question is how to move this agenda forward. Keys 5 through 7 will require more cooperation from all parties, with Key 5 requiring a stable, corruption-free, socioeconomic framework that facilitates positive change. Governments, as the representatives of all sectors of society, are responsible for setting this framework. Neither business nor the NGO community can substitute for this legitimate government responsibility. Key 6 requires all parties to recognize the value provided by nonmarketed environmental goods and services—clean air, fresh water, fertile soils, and aquatic ecosystems. If society allows continued degradation of "free" ecosystem services, then everyone loses. Historically, most efforts to privatize public goods and make an individual or firm responsible for managing common resources have been met with controversy. Governments need to find clever ways of using market-based incentives as well as selective regulations to preserve those natural systems that remain outside the market. Key 7 is the ultimate challenge. How can markets be made to work for the poor? Without creativity and innovation, the Millennium Development Goals (MDGs) for poverty alleviation may not be met. Here society comes face to face with an important challenge—how to unleash human ingenuity without creating new problems greater than those that we sought to solve? The tension between precaution and innovation cannot be wished away.

In 1997, the Asia and Pacific Conference on Consumers in the Global Age called for amendments to the UN Guidelines for Consumer Protection and creation of a model law on consumer protection for the region. The UN guidelines, originally drafted in 1985, were subsequently revised in 1999 based on a discussion paper largely prepared by Consumers International entitled, *UN Consumer Protection and Sustainable Consumption: New Guidelines for the Global Consumer*. In it, sustainable consumption is defined as how the goods and services required to meet basic needs and to improve the quality of life can be selected in ways that reduce the burden on the Earth's carrying capacity. Sustainable production focuses on improving environmental performance in key economic sectors. The two concepts are inextricably linked.

The guidelines baldly state that, "unsustainable patterns of production and consumption, particularly in industrialized countries, are the major cause of the continued deterioration of the global environment." While the world does not appear to be running out of resources, the overexploitation of global fisheries, mass extinction of species, rising emissions of GHGs, and global climate change are indicative of alarming trends. Nevertheless, some still believe that poverty is a greater threat to the natural environment than affluence is, so from that perspective, the "temporary" deterioration of environmental quality in developing countries until the poor escape from poverty may be justifiable.

Specific roles envisaged for business in the UN guidelines include (i) promoting sustainable consumption through the design, production, and distribution of goods and services; (ii) partnerships with governments and civil society to promote sustainable consumption through a mix of policies that could include regulations, economic and social instruments, sector policies, providing information, removal of subsidies, and promotion of best practices; and (iii) partnerships with governments and other organizations to encourage the transformation of unsustainable consumption patterns by developing new, environmentally sound goods and services.

By 2002, the lack of specificity in the UN guidelines as well as insufficient progress in meeting the goals of sustainable production and consumption resulted in one of the key initiatives of the WSSD's Johannesburg Plan of Implementation (JPOI)—the development of a 10-year framework of programs for sustainable production and consumption. Its purpose was, "…to accelerate the shift toward sustainable consumption and production to promote social and economic development within the carrying capacity of ecosystems by addressing and, where appropriate, de-linking economic growth and environmental degradation through improving efficiency and sustainability in the use of resources and production processes and reducing resource degradation, pollution, and waste."

Regional meetings have already been held to further this process, including two gatherings in Asia and the Pacific.[37] Preliminary ideas on a regional strategy have been developed with indications of needs and priorities. One proposal is to establish a "help center" with the support of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and UNEP's regional office. At the first meeting in Yogyakarta, there was a call for, "International organizations such as UNEP, United Nations Industrial Development Organisation (UNIDO), the Asian Productivity Organization, ADB, and national productivity organizations to strengthen existing institutions such as National Cleaner Production Centers to

enhance their service packages to promote sustainable consumption and production patterns, for example, by including product-related issues, inter alia, life cycle analysis and product and service design and marketing." Subsequently, an international expert meeting on the 10-year framework of programs for sustainable consumption and production was held in Marrakech, Morocco. One hundred fifteen experts from 59 countries and nine international organizations concluded at that time that the challenge continued to be finding ways to move from "the more generic to the specific and [to] focus on implementation."

The regional expert meeting in Yogyakarta called on industry to (i) carry out self-assessments; (ii) provide credible self-declarations on their products and services; (iii) develop and follow codes of conducts; (iv) assist SMEs in their supply chain to develop sustainable production and consumption practices; (v) adopt sustainable procurement practices; and (vi) increase research and development on consumer behavior and sustainable production processes, products, and services. UNEP was encouraged to explore the possibility of an international declaration on sustainable production and consumption. So far, the development of the 10-year framework has not extended beyond a series of international meetings, but the admonition to move from generic to specific and to focus on implementation cannot be neglected much longer.

Several northern hemisphere think tanks have addressed these complex issues. For example, the "natural step" program[38] proposes the following:

- elimination of waste;
- elimination of harmful emissions;
- use of renewable energy only;
- adoption of closed-loop processes;
- use of resource-efficient transportation;
- energizing of people (all stakeholders) around this vision; and
- redesign of commerce so that a service is sold that allows the company to retain ownership of its products and maximize resource productivity.

The Wuppertal Institute in Germany and the World Resources Institute in the US have been leaders in calling for "full-cost pricing" to reflect the value of natural ecosystems, their consumption, and the services they provide. At the microeconomic level, environmental externalities—namely, the neglected social costs of environmental damage—must be internalized into business and consumer budgets. At the macro-level, governments should adjust national income accounts to reflect positive "green" benefits and delete costs associated with environmental remediation. It makes no sense for negative expenditures such as cleaning up after disasters that could have been prevented to be accounted for as increases in the economic wealth of the nation.

The term "natural capitalism" has been used to indicate a shift in thinking from destructive consumption of the planet's most important capital, nature, to working within its complex system of ecosystem services already delivered outside of the market system and worth more than the total global economy.[39] To achieve sustainable production and consumption, the Aspen Institute, originators of this concept, proposes four principles: (i) increase resource productivity (by at least a factor of 10), (ii) eliminate waste by redesigning an economy based on closing the loops of material flows, (iii) shift from processing materials and making things to creating services and flows, and (iv) rehabilitate the planet by investing in natural capital. Others have referred to the concept of cradle-to-cradle industries or a "circular economy," rather than the linear cradle-to-grave approaches. This concept has begun to find practical application in the PRC, where central and local governments recently were encouraged ro adopt the circular economy concept as they prepared activities to be covered under the 11th Five-Year Development Plan (2006-2010). The government has committed to operationalizing the circular economy concept in several major sectors and regions.

The Netherlands is arguably the most advanced country in relation to sustainable production and consumption.[40] Since its first National Environmental Policy Plan (NEPP) in 1989, the Netherlands government has set overall targets and entered into covenants with sector stakeholders to meet these goals leaving the choice of means to those who are believed to know best. Setting targets for consumption and entering into covenants with consumers has not been as simple as doing so for production sectors like the chemical industry. Interestingly, the Netherlands Social and Economic Council (SEC) distinguishes between the role of a citizen concerned about problems facing society and the role of the consumer concentrating on self-interest although they are embodied in one person. The consumer is part of the production chain (purchase, use, and disposal), whereas society sets standards and licenses the production chain to operate under certain conditions. Sustainable consumption, therefore, requires a consonance between social and individual behaviors. Unfortunately, humans are quite capable of simultaneously holding social views that are markedly different from their private behaviors. To deal with such dilemmas, the Dutch SEC recommends a mixture of carrots, sticks, and sermons (i.e., making clear the alternative sustainable behavior, minimizing or compensating for personal sacrifices, and internalizing the desired behavior so that deviations are seen as antisocial aberrations and invoke public censure). Product information and the ready availability of sustainable alternatives are essential in bringing about such behavioral changes.

Sustainable production and consumption (or natural capitalism) is not just a theoretical concept. Numerous best practice cases have been documented, many of them derived from employee suggestions ranging from reductions in the energy content of products, to making buildings more energy efficient. The key question for corporations and consumers is whether to seek these solutions voluntarily because they add to both profitability and to a sustainable society or to wait until they become mandatory. Given the history of this issue in the UN system since 1972, an international declaration on sustainable production and consumption seems almost inevitable. That would, in turn, lead to national commitments and legislation. Transitional policies being adopted in the European Union (EU) already serve as useful guides to future global actions.

In summary, whether future programs to make both production and consumption sustainable are voluntary or mandatory may be a moot point. Business leaders in Asia and the Pacific would be well advised to become involved now; they should take the initiative to design effective voluntary programs that they can live with rather than take a "wait-and-see" attitude thereby risking future imposition of mandatory programs that could be punitive.

Equator Principles

In June 2003, several of the world's largest private financial institutions adopted the Equator Principles. Developed by the World Bank's International Finance Corporation (IFC), this code of conduct seeks to ensure that large projects (of over $50 million in capital) financed by signatory organizations are developed in a manner that is socially responsible and reflects sound environmental management practices. Currently, 30 of the world's largest banking groups have signed on to the Equator Principles, accounting for about 75% of the investment in emerging markets ($55.1 billion in project loans in 2003).

These financial institutions are required to review carefully all requests for project financing and to categorize the risk of a project in accordance with prescribed internal guidelines. For category A (significant adverse environmental impact) and selected category B (less adverse environmental impact), an environmental management plan is required covering mitigation, action plans, monitoring, management of risk, and schedules. If necessary, a decommissioning plan must also be prepared. These categories cover major

capital investments and do not cover smaller loans. While the number of loans and projects covered is relatively small, this exercise sends an important signal to all business leaders. Either the borrower or a third-party expert must have consulted, in a structured and culturally appropriate way, with project-affected groups including indigenous people and local NGOs. The EIA must be made available to the public in the appropriate local language and in a culturally sensitive manner for a reasonable minimum period of time. The IFC is providing customized training to bank staff. As necessary, the lenders will employ additional expertise to provide additional monitoring and reporting services.

The $3.6 billion Baku-Tblisi-Ceyhan oil pipeline project, financing for which closed in February 2004, was the first major test of the Equator Principles as it was the first category A project. Baku-Tblisi-Ceyhan will transport oil from Azerbaijan through Georgia to the Turkish port of Ceyhan on the Mediterranean. The pipeline solves the problem of commercializing Caspian oil without shipping it through the fragile and overcrowded Bosporus Straits. The project presents a number of environmental and social challenges, including pipeline routing near potentially critical habitats, the claims of various groups for special recognition and compensation, seismic activity, and political turmoil in Georgia. The project attracted and continues to attract considerable negative NGO concern.

As a result, 13 of the major environmental NGOs met with 16 of the Equator Principle banks in July 2004 and agreed to form a small working group to examine how NGOs can work productively with the banks and how to make reporting on the implementation of the principles more transparent. Business leaders have consistently indicated that they accept an open and transparent process, but in return, they want a final decision that will end protracted wrangling. They become discouraged when some environmental NGOs remain critical no matter how thorough the review process. At this meeting, the participating banks also signaled that the Equator Principles are only one element, albeit an important one, of their overall environmental policies. In fact, in one of the consultation workshops held for AEO 2005, several of the banks indicated that the "large project trigger" is not really needed because they now use the same principles for any environmentally sensitive project, regardless of size.

For businesses that think there are plenty of other banks in the world, the avowed goal is to have a critical mass of leading banks announce the adoption of the principles so that they become the de facto banking industry standard. More banks can be expected to adopt the Equator Principles in coming years.

Global Reporting Initiative

The Coalition for Environmentally Responsible Economies (CERES) is collaborating with international accountancy bodies, financial institutions, environmental organizations, government and quasi-government agencies, and public interest groups in implementing the Global Reporting Initiative (GRI). This is an innovative effort to harmonize environmental and social accountability and the reporting practices of many organizations[41] and to elevate them to the same level of acceptance now accorded financial reporting. As an autonomous organization, GRI encourages all companies to measure and report consistent, timely information that will assist analysts, investors, and other stakeholders in comparing corporate performance within a given sector. Company reports that meet the GRI guidelines are regarded as models for the Global Compact's Learning Forum.

In 2002, GRI released its revised sustainability reporting guidelines. More than 700 corporations had adopted the guidelines; however, to date, only a handful of firms from Asia and the Pacific have signed on. As with financial reporting standards, which are still undergoing continuous improvement 50 years after they were first introduced, the sustainability reporting guidelines are viewed as a work in progress, and a new version is under preparation. In fact, much of the recent development in accounting standards, partly driven by a wave of corporate scandals in Europe and the US, involves accounting for intangible assets such as corporate and brand reputation, alliances and partnerships, human capital, and environmental capital and liabilities. Hence, sustainability reporting is converging with broader accounting principles and many companies are now integrating sustainability reports into their normal annual financial reporting cycle.

Many businesses and trade associations have already endorsed the concept of sustainable development reporting. Issuing an environmental report is a requirement of membership in WBCSD, and members are encouraged to look at the indicators proposed by the GRI. All members are encouraged to go beyond environmental reporting and move toward sustainable development reporting covering the economic, environment, and social performance of the firm. Many firms use the GRI as a guide to ensure that they have covered all of the issues recommended for inclusion in reports. Accounting firms and independent NGOs have created new business lines in conducting third-party evaluation and validation services. Skeptical environmentalists were initially concerned that voluntary self-reporting would result in "greenwash"—talking about environmental stewardship but failing to "walk the talk." Third-party validation usually addresses this concern.

The benefits of sustainability reporting are manifold but include (i) building, sustaining, and continually refining stakeholder engagement with the firm; (ii) linking typically discreet and insular functions of the corporation in a more strategic manner, thus opening up internal conversations that would not happen otherwise; (iii) early warning of potential trouble spots (and unanticipated opportunities) in the supply chain, customer base, regulatory framework, or affected communities; (iv) creating a more complete picture of long-term prospects and new business opportunities; and (v) reducing volatility and uncertainty in share prices and raising capital, by avoiding unwelcome surprises.[42] Although the guidelines are voluntary at this stage, reports following them allow for comparability and benchmarking thus providing managers with useful feedback on performance while legitimate differences between firms and sectors are recognized. Such benchmarking will also become an important input to the decision-making processes of the socially responsible investment (SRI) funds discussed in the next section.

In addition to the guidelines, the GRI is developing (i) sector supplements to capture the unique sustainability issues of certain sectors such as mining or banking; (ii) guidance documents on topics such as "diversity" or "productivity"; and (iii) technical protocols providing definitions, procedures, formulas, and references for each measurement indicator. Indicators are divided into "core" and "additional." GRI has also prepared a trimmed-down version of the guidelines for SMEs as well as modifications for government and international agencies. GRI complements other tools of sustainability such as charters or codes of conduct, organizational policies, industry standards, voluntary initiatives and agreements, and environmental management systems (EMS) which are addressed in subsequent chapters.

The environmental performance indicators cover (i) materials; (ii) energy; (iii) water; (iv) biodiversity; (v) emissions, effluent, and waste; (vi) the environmental performance of suppliers; (vii) the environmental impacts of products and services including the ability to be recycled or reused; (viii) compliance with all relevant international declarations, treaties, and agreements and all relevant national, subnational, regional, and local environmental regulations; (ix) transport; and (x) environmental expenditures. Thus, in theory, it should be possible to link a sufficient sample of compliant sustainability reports to national reports on environmental performance. In the new information age, environmental

reporting is one way for firms to communicate with shareholders, employees, suppliers, the financial community, and other stakeholders. The reports provide an opportunity for firms to set forth their visions for the future, corporate commitments, goals, and performance in attaining those goals. There are emerging financial rating institutions that compare companies and rate them for investors. Verifiable reporting is one key checkpoint in all of these rating schemes as firms strive to be the best in class. Thus, reporting is becoming a crucial factor for institutional image and recognition. Progressive and competitive firms increasingly recognize that they are being monitored everyday. There is no place to hide. It takes time, money, and effort to build a positive public image, and this becomes an important and valuable asset of the corporation.

Socially Responsible Investment and Stakeholder Advocacy

The Aspen Institute reports that, "…a small but growing segment of the financial community is beginning to recognize and reward the publicly traded businesses that are identifying business-environmental linkages. From SRI funds that traditionally have often screened out entire industries to the emerging environmental value funds and research services that look for top environmental performers in each industry, more and more investment money is moving in the direction of environmentally well-managed companies."[43]

In 1999, Zurich-based Sustainable Asset Management (SAM) joined forces with Dow Jones & Company to establish the Dow Jones Sustainability World Indexes (DJSI), the first major benchmark tracking the financial performance of sustainable leaders on a global basis. According to SAM's chief executive officer, "…it is clear that sustainability is moving into mainstream asset management." More and more now believe that integrating economic, environmental, and social success factors into business strategy can result in competitive advantage (see Box 2). Although sustainability funds represent less than 1% of the entire market, there is an emerging body of evidence that those companies earning entry onto the DJSI outperform broader stock averages. Currently, several mainstream institutions use DJSI and SAM analysis to manage funds and derivatives.[44]

An IFC-sponsored project that reviewed SRI in emerging markets found that global SRI comprising more than 760 retail funds and many individual investors had more than $2.7 trillion in assets under management.[45] However, less than $1 billion of that was in Asia. US assets controlled by shareholder advocates, another form of SRI in which share ownership is used to advocate socially or environmentally responsible behavior, was almost $900 billion. A recent study found SRI funds at least equal to non-SRI funds in emerging markets, including Asia.[46] SRI funds continue to outperform their benchmark comparators, at least in part because screened firms tend globally to be long-established, large-capital companies that intend to be around for the long haul.[47] This superior performance has, in turn, convinced some of the world's largest institutional investors, such as the California Public Employees Retirement System to employ social and environmental criteria in their investment guidelines. Thus far, however, companies in Asia and the Pacific are largely missing out on a potentially huge source of investment.

Leading-edge companies are integrating environmental considerations into their core businesses and are gaining a competitive advantage from doing so. With luck, companies going beyond compliance may enable investors and analysts to identify outperforming firms that can generate high rates of return on investment. Some of the trends that will drive these changes include (i) the adoption of quality management systems, (ii) global expansion limited by a company's environmental reputation, (iii) the need to manage environmental performance along the entire supply chain, and (iv) product differentiation based on environmental products and services.

To mobilize more SRI in emerging markets, the IFC has offered three recommendations. First, incentives should be provided to establish support networks for professionals involved in emerging market SRI (such as conducting research on best practice SRI financial regulatory frameworks and enforcement and creating a multinational "SRI in emerging markets" working group). Second, better SRI corporate performance data should be collected and disseminated at low cost. Third, institutional investors should be motivated to invest in emerging SRI markets, possibly through the creation of a high-profile emerging market SRI fund.

Box 2: Socially Responsible Investments and Corporate Behavior

In a recent global survey of investment managers regarding socially responsible investment (SRI), 89% said it will become commonplace within 10 years for companies to have policies and strategies qualifying them as socially responsible, 73% believed that incorporation of social and environmental corporate performance indicators will become mainstream within 10 years. Among Asian and Australian managers, 85% said all SRI practices will become mainstream within 10 years."*

Another report showed a close relationship between corporate reporting and the existence of SRI funds. Entry of SRI funds into an equity market puts pressure on companies to provide detailed data on their environmental and social responsibilities and this encourages them to improve corporate governance and their own standards of corporate reporting.** In Japan, for example, "levels and quality of corporate reporting jumped dramatically in line with the establishment of SRI funds. While global SRI funds are hesitant to enter some countries with low corporate governance scores, such as the Philippines and Indonesia, the report concludes that by entering these markets and actively engaging with leading companies, SRI funds can play a significant role in encouraging the adoption of improved corporate governance, corporate social responsibility (CSR), and SRI by the wider market.

In a third survey conducted among stock brokers and fund managers, 100% of the respondents indicated that the environmental, social, and corporate governance criteria impact both positively and negatively on long-term shareholder value.

*Mercer Investment Consulting. 2005, 21 March. *SRI: What Do Investment Managers Think?* www.merceric.com
**ASRIA. 2003. *SRI in Asian Emerging Markets.*

Anti-Globalization Movement

The violent demonstrations against the World Trade Organization (WTO) meeting in Seattle in 1999 took many by surprise. The single coherent message seemed to be, "we're mad as hell and we're not going to take it anymore." Following is a partial list of the groups and key objections raised:

- trade unions: free trade would threaten jobs, especially in developed nations;
- farmers and fishermen: ending subsidies would subject them to "unfair" competition from developing nations;
- environmental NGOs: WTO would ignore environmental and social issues during trade negotiations;
- human rights groups: globalization would spark a "race to the bottom" and workers would be exploited;
- culture activists: globalization would substitute western culture for traditional local culture and products;
- political activists: the collapse of communism left the world with no viable alternative to a free market liberalism that fails to provide adequate safety nets for those left out of the system;
- anti-MNC activists: state governance mechanisms are no longer capable of regulating runaway MNCs;
- anticorruption activists: bribery and corruption prevent the poor from the benefits of increased economic activity.

After Seattle, the anti-globalization forces targeted the annual joint meetings of the World Bank and the International Monetary Fund (IMF) as well as the meetings of the

Group of 7 leaders of the most-developed nations (Group of 8 if Russia is included). These protests also attracted small groups of anarchists willing to launch attacks against property and who consider the police as symbols of repressive authority. McDonald's and Coca-Cola were favorite targets as primary symbols of decadent western culture. Banks as well as shops selling luxury products were also targets. After a death during the G8 meeting in Genoa, Italy, future meetings were held at more isolated locations where public access could be controlled and security made more certain. Thus, the G8 meeting in France was held at the small resort of Evian while protesters massed in Geneva, 50 kilometers away. The meeting in Canada took place in the Rocky Mountains where access was difficult for uninvited guests. The US hosted its G8 meeting in Sea Isle, Georgia. Closing the bridge to the island kept the protesters far away from the actual meeting.

These protests reflect deeply held resentments about the perceived unfairness and unevenness of the benefits of increasing wealth worldwide. It is easy to denigrate these protests for their violence and their lack of a cohesive set of alternatives. It is also relatively easy to show that the very institutions that they rail against have enabled millions to escape poverty. Their argument is that the process of poverty alleviation is too slow, that the elites have benefited excessively, and that there is something morally bankrupt in a world system where 2 billion live in luxury while the other 4 billion are struggling just to survive.[48]

It was clear from the "Battle in Seattle" that many were disturbed by the reluctance of the WTO to give environment and social concerns adequate consideration during trade negotiations. Trade union hostility was expected. They had fought hard to kill the North American Free Trade Agreement despite the concessions made on labor and environmental issues. The Democratic administration in the US supported it, and the Republican Congress approved the pact. This was a bitter defeat for the US unions and the labor movement in general. Now the WTO was launching another round of negotiations to move further toward free trade, so there was a relatively clear "fair trade" argument with fair trade being viewed as code words for protectionism of domestic markets and jobs. Other trade dissidents from around the world joined the American trade unions in the protest.

During the 2004 presidential race in the US, the "outsourcing of jobs" from developed to developing nations entered the picture as another contentious debate related to free trade. From the rhetoric involved, one could imagine that unemployment rates in the US must be high and rising. Data show that the rate is actually lower than in Europe and declining. After the death in Genoa and the shock of the terrorist attack on the World Trade Center in New York in September 2001, all protest groups appear to have moderated the militancy of their views. The World Bank/IMF/ Ministers of Finance meeting in Washington, DC in October 2004 attracted few protesters and no violence.

Clearly, the anti-globalization movement remains a concern for business, especially large corporations attempting to expand globally. Its immediate impact on the business environment is unclear except that it might slow down the rate of economic expansion and the benefits of poverty alleviation. The movement will certainly cause government negotiators of future free trade agreements to be more aware of concerned environmental NGO positions. Harmonization between multilateral environment agreements (MEA), some of which restrict environmentally damaging trade, and free trade agreements is already a contentious issue being thrashed out in numerous meetings and conferences.

Consumer Preferences and Boycotts

"Consumers are increasingly interested in the world that lies behind the product they buy. Apart from the price and quality, they want to know how, where, and by whom the product has been produced. This increasing awareness about environmental and social issues is a sign of hope. Governments and industry must build on that."[49] "Sustainable consumption is not about consuming less, it is about consuming differently, consuming efficiently, and having an improved quality of life."[50] Consuming differently means more quality and knowledge and less quantity and waste. There is emerging evidence that consumers are well ahead of their governments in demanding improved environmental performance from the goods they buy.

In a recent global survey of public opinion, 64% of respondents ranked pollution and environmental problems as very serious (almost the same as terrorism and the spread of human diseases), while 52% ranked loss of plants and animal species as very serious problems. In relation to corporate responsibilities, 69% said that companies should be operationally responsible for not harming the environment while 67% said that companies as responsible citizens should restore the environment for the future.[51] Almost 80% said that corporations should be responsible for restoring the environment for future generations. It is this level of awareness that is translating into purchasing decisions.

The business community seeks to make profits by meeting human needs for goods and services. Despite the billions spent on global advertising, a consistent corporate position is that it is not in the business of telling people what and how much they should consume. As the chairman of Shell International said at a recent stakeholder dialogue, "…our business is offering choices…if the consumer does not want to buy it…we won't make it." However, business does have a responsibility to provide a range of information that enables consumers to make informed choices. This information package needs to cover performance, value, safety, reliability, and environmental information.[52]

In the marketplace, the consumer is the theoretical "king." However, many remain concerned that consumers are unfairly manipulated by advertising and information provided by opinion leaders. Veblen's *Theory of the Leisure Class*[53] firmly established the notion of conspicuous consumption, combining status and utilitarian functions. That means that we often consume to impress others, to win an attractive mate, or to demonstrate our position in the social pecking order. The standard microeconomist's stance is that we consume only for the personal utility or satisfaction that consumption brings. Thus, we are forever condemned to consume until the marginal utility of consumption is exceeded by the marginal cost of purchases. However, if that standard utility function is conditioned by where we see our rightful position in the pecking order or by how others might view the external manifestations of our consumption, then we may be perpetually disappointed instead of satisfied. If our consumption of brand name goods does not deliver either the satisfaction of the functional nature of the goods nor the social positioning that the advertising industry promised, we do not take the obvious lesson and stop consuming but often redouble our efforts. If there is always some group of wealthier people just ahead of us, consumption can become a deeply unsatisfying race to keep up. Despite manifold increases in gross national product since World War II, average happiness has not increased in developed countries.[54] Consumption does not equate to happiness.

Maslow's "hierarchy of individual needs" suggests that once the basic needs of people for food, clothing, and shelter are met, individuals seek safety and security.[55] Then they move on to concepts such as social belonging, self-respect, aesthetic needs, and finally, self-actualization and transcendence. At the bottom of Maslow's pyramid, people will do whatever is necessary to survive, which explains why poverty may lead the poor to

destroy the very environment on which they depend. The question is whether aesthetic needs and self-actualization at the top of the pyramid will lead to a focus on customized, quality goods and services or to an endless spiral of conspicuous consumption without regard to the impact of that consumption on the natural carrying capacity of Earth and its ecosystems and natural biodiversity.

In 2004, Redefining Progress released its latest version of Ecological Footprints of Nations.[56] An ecological footprint is, "…a tool for measuring and analyzing human natural resource consumption and waste output within the context of nature's renewable and regenerative capacity." The basic premise is that if we remove more from nature than can be sustained indefinitely, then we are on an unsustainable track as a species. The 2004 report found that the per capita ecological footprint continued its 20-year adverse trend and for the first time, the US became the nation with the largest per capita ecological footprint, at 9.5 hectares per person (5 times the sustainable average). Accordingly, any attempt to reduce consumption to an ill-defined, sustainable level should start with consumers in the US and Europe.

Do consumers worry about the ecological footprint of their consumption? Opinion surveys indicate that they do, while the response at the political level suggests that political action lags behind public opinion. For example, strangely missing from the MDGs is any mention of consumption patterns despite the evidence that overconsumption is causing a global epidemic of obesity in developed countries and threatening the global environment. Sadly, many developing countries appear to be striving to emulate similar consumption and lifestyle behaviors as their measure of "development." It is notable that JPOI merely proposed a decade-long study of production and consumption. Contrast this meek official response to some of the dire warnings about the continuing global preoccupation with overconsumption.

Consumption in many rich nations continues to grow, much of it reasonably classed as "overconsumption" in comparison to the material goods available to the average human being. Population growth continues in the US, now the third most populous nation in the world (294 million) and heading toward 420 million in 2050. The US has a population growth rate (thanks largely to immigration) of over 1%. More importantly, it has an extremely high level of consumption per person—10 to 30 times that of people in developing nations. "The spread of American consumerism is a global threat, and the prospect of ever greater disparities in living standards not only between nations but within nations, bodes ill for the environment."[57]

If it is true that we consume mainly to gain utility from the functional properties of goods, why do we accept planned obsolescence and purchase products that break down the day after the warranty expires? Like the environmental cost of pollution produced during manufacturing, the costs of disposal are not reflected in product prices and must be shared by those who have not enjoyed the often very temporary pleasures of consumption. The rapid growth in leasing arrangements indicates that consumers have accepted that a car or computer will soon become obsolete and there is little point in owning something that will soon need to be replaced. Failure to internalize post-consumer costs into product prices explains why there is not a greater business emphasis on providing services rather than the things that provide those services. Did previous generations who built things to last have a better understanding of consumption than modern throwaway societies? Perhaps there was a closer relationship between consumers and disposal costs. In any case, these are illustrations of some of the questions that will need to be addressed if sustainable consumption is to be defined and addressed.

Gradually, modern consumers and their advocacy groups are learning the power that they hold over producers and exercising their desire to encourage production of environmentally sound goods and services. The power of "rejectionist" consumers is exemplified by the difficulty producers of genetically modified organisms (GMO) have faced in opening European markets. How can we account for such consumer advocates and activists clearly operating in a noneconomic manner? Are they simply neo-Luddites, opposed to technological advancement, or is there a deeper set of risk premiums and values at stake? Values that can resist the blandishments of social marketing techniques and the seductive power of advertising could be a powerful model sought by those who are promoting a simpler, less consumption-oriented lifestyle. Proponents of voluntary simplicity observe that, "only with greater fairness in the consumption of the world's resources can we live peacefully and thereby live sustainably as a human family."[58]

It is not certain that continued global environmental degradation will motivate affluent consumers to moderate or adjust their purchasing patterns. Nevertheless, there are some initial signs of such change. The Max Havelaar Foundation[59] has launched successful campaigns in Europe to encourage consumers to pay premium prices for products from poor farmers in the developing world (bananas, coffee, tea, honey, cocoa, chocolate, sugar, orange juice, flowers and plants, mangos, pineapples, and rice). Coffee companies encourage consumption of "shade grown" coffee that is more environmentally friendly. Consumers appear willing to pay premiums for quality products, as has long been recognized by the luxury goods market. Consumers purchase prestige products for multiple motivations but primarily for sociability and self-expression.[60] Similar consumption patterns may be found to be expanding across Europe and North America in response to various green labeling and certification efforts.

Commercial advertising, often criticized for its use in stimulating excessive consumption, also could be a potent force to help shift purchasing behavior toward products in line with habits that enhance rather than hinder sustainability. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) has already collaborated with a major advertising company to communicate the essence of sustainable development and influence the advertising industry.[61] Some companies have used "social marketing" to raise awareness of health issues such as dental care in Zimbabwe and women's health issues in the PRC. There is no reason why advertising cannot be shifted away from further intensifying consumption problems to promoting solutions—provided someone is willing to pay for it. Business could apply the influence of the media to promote different visions of "the good life." By creating consumer awareness of sustainability through advertising, business could encourage people to support sustainability through their purchasing power. However, there is no point in advertising eco-efficient living if business does not simultaneously deliver eco-efficient products and services as part of a deliberate strategy to increase market share.

Given the consumption patterns of the developed world, it seems hypocritical to suggest that consumers in developing countries should not aspire to "modern" mass consumption lifestyles. If affluent nations significantly altered their current consumption patterns, then theoretically there would be room for greater consumption in developing countries without increasing total environmental impact on global ecosystems. Most of the world's population, both in developing and developed nations, still does not see environmental problems—such as the threat of global warming, loss of biodiversity, and depletion of the world's fisheries—as threats that apply to them personally, certainly not in the short term. Those in the developing world look at the quality of life in affluent nations portrayed in the media and want the same and as soon as possible! They have neither accepted nor internalized warnings from environmentalists that we already are exceeding the carrying capacity of the globe. Even the concept of the carrying capacity of ecosystems and of the "spaceship nature of

Earth" is difficult for most people to absorb. It is still easier to be naively optimistic than to heed warnings about poorly understood global systems. Many consumers appear to be in denial, not wanting to hear the bad news about the consequences of their actions if it means preventing them from sharing in the good life.

Once stirred to action, however, consumers can be very effective in voting with their purchasing power, including the boycotting of companies in breach of social norms. In January 2001, for example, seven officials from a company that manufactures monosodium glutamate, a ubiquitous taste enhancer in Asia and the Pacific, were detained in Indonesia. The East Java factory producing the additive and associated warehouses were sealed, products withdrawn from supermarket shelves, and the share price fell by over 14%. The Indonesia Council of Ulemas (Muslim religious leaders) had delivered a fatwa (ruling) that that particular brand was not halal (and therefore forbidden to be eaten by Muslims). The reason stemmed from a revelation that the company used an enzyme from bacteria grown on pork extracts to speed up the chemical reactions involved in production. The company quickly moved to assure Indonesian consumers that it no longer used this method to produce its enzymes, but only after considerable financial damage.

The Ethical Consumer[62] maintains a registry of current boycotts in the United Kingdom (UK)—a list which early in 2005 included firms using kangaroo skin to make football boots, airlines transporting primates for research, pharmaceutical firms using horses in producing drugs, companies producing genetically modified crops, a beer company using orcas as performing animals, a soft drink company allegedly repressing trade unions in Columbia, a car manufacturer for failure to pay reparations for use of slave labor during World War II, an oil company for lack of action on climate change, a fast-food chain for cruelty to chickens, plus many others.

Such boycotts can be economically punishing for the firms affected. For example, one of the most effective boycotts occurred in Germany during a dispute over decommissioning of the Brent Spar "oil rig" (a 137-meter-high storage buoy). Following a boycott of the company's petrol stations, sales declined by more than $100 million. The oil company capitulated within a week and agreed to abandon its original plan to tow the rig out to sea and sink it in deep ocean waters. In addition to the lost income, the company faced higher costs of dismantling the rig on land.[63] Both the UK government and the company maintained throughout this drama that ocean disposal remained the best environmental option.

Stockholder advocacy also is on the rise and can significantly influence internal policy, particularly during annual meetings. Perhaps one of the most significant groups espousing the power of stockholders is the Interfaith Center for Corporate Responsibility,[64] a coalition of 275 Protestant, Catholic, and Jewish congregations with over $100 billion in assets with a mission to promote corporate responsibility. Its member groups posted stockholder resolutions in 2003–2004 on GHG emissions, GMOs, sustainability reporting, drilling in the arctic wildlife refuge, the impact of the Bhopal accident, the release of dioxins into the environment, and renewable energy. Most of these boycotts and shareholder actions are directed at specific incidents or unethical behavior with only a limited number addressing broader global concerns.

Environmental and social activists face a dilemma in their efforts to modify consumer preferences. They have to educate consumers, but it is unclear if consumers respond to objective, science-based information or whether it will take reference to more dramatic warnings of impending disasters to capture the public's imagination. Are consumers "turned off" by too many negative warnings? Do these warnings create more confusion or denial than genuine concern that generates positive action? Will it take a demonstrable global catastrophe to stir consumers into action? What will be the impact of "counterattacks" from skeptics exemplified by the controversial book, the *Skeptical Environmentalist*?[65] Perhaps more time and effort needs to be spent creating consensus among leaders in business, government, and NGO groups that will have credible staying power. The solutions to many longer-term global environmental problems will require coherent long-term strategies rather than a series of ephemeral ad hoc reactions to the crisis of the day. Nevertheless, business leaders in Asia and the Pacific should be aware of the power of consumer preferences and should monitor the broad changes in preferences and expectations beginning to emerge both in their developed-country markets and at home.

Patent Protection and Intellectual Property Rights

The Patent Cooperation Treaty was first signed in 1970 and has been amended several times since. The latest version, in force since 2002, provides protection and legal remedies for registered inventions. By filing one international patent application, an inventor can seek simultaneous protection in over 100 countries, including a number of developing countries. The World Intellectual Property Organization is helping developing countries to improve patent protection laws and to ratify the Patent Cooperation Treaty as well as the Madrid system for international registration of marks and the Haque system for international registration of industrial designs. Similar protection is afforded copyrights through the Berne Convention for the Protection of Literacy and Artistic Works. Plant varieties can be protected by patents or by a special system (such as breeder's rights under the International Convention for Protection of New Varieties of Plants).

The Trade in Intellectual Property Rights (TRIPS) Agreement (Annex 1C of the Marrakesh Agreement Establishing the World Trade Organization) was negotiated as part of the 1986–1994 Uruguay round on international trade negotiations. For developed countries, the TRIPS provisions came into force in January 1996. Developing country members of the WTO were given a transition period until January 2000 and least developed countries were given until January 2006 (pharmaceutical patents have been extended to 2016).[66] The TRIPS Agreement makes intellectual property rights (essentially copyright and patents) an integral part of the multilateral trading system. As an indicator of the economic significance of such innovation and the importance of these protections, copyright industries in the US in 2002 accounted for 6% of gross domestic product or $627 billion, employed 5.5 million workers, and exported $89 billion of goods (books, movies, software, etc.).[67]

The International Chamber of Commerce estimates that 7% of global trade is counterfeit and that counterfeit sales are worth $350 billion per year.[68] The Business Software Alliance estimates that software piracy alone is worth $29 billion per year.[69] Counterfeit automobile parts cost the industry approximately $12 billion per year in lost sales and reduce legitimate jobs by 200,000 in the US. Fake diet pills, infant milk formula, wines and spirits, and automobile parts (such as brake pads made of sawdust) also have caused injury and loss of life.[70] The International Federation for the Phonographic Industry estimated that 1 billion counterfeit music compact disks were sold in 2003 (one out of every three sold) valued at $4.5 billion, or 15% of the global recorded music market. Of the top 10 offending countries, half are in Asia and the Pacific.[71]

However, such illegal activity is becoming increasingly difficult in the region partly due to increased government action but also due to developed-country firms taking direct action. Lightning raids on manufacturers or outlets selling fake products is now a major activity of security firms in the region. There is even some evidence that terrorist and organizational crime groups are engaged in the counterfeiting trade, thus doubling the determination of authorities to crackdown on these practices.

New technologies are being employed to deter fakes from being sold. In apparel, deoxyribose nucleic acid (DNA) signatures are being woven into the cloth as fancy watermarks and holograms are apparently too easy to copy.

The DNA can be sprayed onto a product as a film, embedded in thread or powder coatings, or mixed into the product compounds. A fluorescent reaction with a special reader authenticates the presence of the DNA. At the Sydney Summer Olympics in 2000, 34 million labels of merchandise were tagged with unique strands of DNA. Revenues lost at the Sydney games were estimated at less than 1%, netting the organizers an additional $700,000 in royalties. The Atlanta games committee in 1996, on the other hand, estimated that half of the merchandise sold around the world was fake.[72]

We sometimes forget that much of East Asia's success in industry was due to the wholesale copying of Western goods. It was not so long ago that "made in Japan" was a derisory term for cheap and poorly made knock-offs of Western products. The PRC, Taipei,China, Republic of Korea, and India have often followed the same development path. Will overzealous protection of patents and copyright bar this path to development for some of the upcoming least developed countries? The need to balance legitimate property rights with an ability to adapt successful designs or products from developed countries will occupy trade negotiators for many years.

Multilateral Environmental and Trade Agreements

There are over 2,000 multilateral and regional environmental agreements, some of which specifically impose binding legal agreements on nations, and in turn, corporations operating in those countries. In the past, few of these agreements had any form of sanctions, so developing countries could sign them without fear of retribution. However, more recent MEAs have begun to move toward legal sanctions for noncompliance, and several have trade-related provisions that directly impinge on corporate activity and the ability to export into developed-country markets (nontariff trade barriers).

Of this multitude of agreements, 238 are regarded as either international treaties or agreements in the environmental field[73] 38 of which contain trade-related measures. Examples that use trade-related measures to achieve their objectives include the Montreal Protocol, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Convention on International Trade in Endangered Species, the Persistent Organic Pollutants and Prior Informed Consent Conventions, and the Biosafety Protocol of the Convention on Biological Diversity. Other MEAs, such as the UN Framework Convention on Climate Control and the Kyoto Protocol, may have significant trade implications in the future, especially through trade in GHG emissions.

Perhaps one of the more perplexing complexities in the alphabet soup of MEAs is the potential conflict between provisions of free trade agreements and environmental restrictions.[74] Developing countries are concerned that developed countries will impose environmental barriers (such as phytosanitary standards) to limit market access as tariffs fall. In workshops for AEO 2005, several developed-country company representatives indicated that they want to see a level playing field so there is no competitive advantage to operating in a country with lower environmental standards. On the other hand, competitive pressure from the globalized market may make it more difficult for environmental advocates and regulators to gain the necessary local support to upgrade environmental standards.

Key to this argument is the WTO trade rule banning imposition of performance and process standards on exporting nations. Importing nations are allowed to require that the exports meet or exceed the requirements for products manufactured in the home nation. NGOs fear a race to the bottom as developing countries offer their comparatively lax environmental standards as a competitive edge to attract foreign direct investment. However, empirical evidence does not support this conclusion, since multinationals normally impose uniform performance and process standards regardless of location. This does not preclude trade-driven economic growth from speeding up the process of environmental degradation in the absence of domestic enforceable regulations or enforcement. More importantly, economic integration has diminished the regulatory independence of developing nations thus accelerating the need for greater international cooperation on MEAs. Global competition and better information may actually set off a race to the top as national companies attempt to match or exceed the performance of competing multinationals.[75] The implications for domestic businesses in Asia and the Pacific are clear. Being a supplier to OECD markets and MNCs will mean complying with more stringent international environmental requirements. Cost is always an issue, but environmental performance and quality control are essential to capturing and retaining market share.

In the early 1970s, the General Agreement on Trade and Tariffs (GATT) Council, the precursor to WTO, established the Group on Environmental Measures and International Trade to examine, upon request, matters related to the trade policy aspects of pollution and environmental protection. No request was made to convene this group until the early 1990s. The starting point was a dispute over the extraterritorial application of the US Marine Mammal Protection Act which sought to stop the incidental killing of marine mammals, such as dolphins, in fishing nets. An adjudication panel found that an import ban on tuna caught in purse seine nets violated core provisions of the GATT and that the less trade-restrictive measure of labeling canned tuna as "dolphin-safe" would allow consumers to state their preferences in the supermarket aisles.[76]

Although there were concerns that Pandora's box may have been opened, the Group on Environmental Measures and International Trade was requested to convene and reported to the 49th session of the contracting parties in 1994. This report was the main input to the decision on trade and environment that formed part of the Uruguay Round Agreement concluded in April 1994. With the formation of the WTO in 1995, environmental issues were firmly ensconced in the multilateral trading system. Trade and environment issues were subsequently, and belatedly, included in the WTO negotiations launched in Doha in November 2001. Developing countries remain skeptical regarding the true intent of this inclusion.[77]

It is generally agreed that trade measures should be included in MEAs only when they are the only or the best way of achieving the stated objectives. Such measures are often used where markets are imperfect, policy failures need to be corrected, or free riders need to be discouraged.[78] Many of these circumstances apply to developing countries in Asia and the Pacific. Specific measures may include monitoring the extent of trade in particular items, labeling, notification and prior consent, targeted export or import bans, or market transforming measures (such as taxes and charges).

The current Doha round of trade negotiations calls for the relationship between existing WTO rules and trade-related provisions of MEAs to be clarified provided they don't add to or diminish the rights and obligations of WTO members. Accordingly, developing country corporations and their proxies in the negotiations should continue to monitor developments in this area. Of particular interest may be the need to clarify the primacy of dispute settlement mechanisms and the most appropriate form of implementing the precautionary principle.

Risk Management

The insurance industry is always concerned with minimizing risks and has been working with UNEP since 1995 on a voluntary insurance industry initiative[79] aimed at helping integrate environmental considerations into their business operations. The cornerstone of the initiative is the Statement of Environmental Commitment by the Insurance Industry,

in which participating companies pledge to make every realistic effort to achieve a balance between economic development and the welfare of society through environmentally sound management activities. Given that insurance losses can be over $30 billion annually and that natural disasters often result in more than 100,000 casualties per year, it is clearly in the commercial interest of the insurance industry to avoid such losses wherever possible. Of particular interest are climate-related losses leading to intensive interest in global warming and the Kyoto Protocol. Currently, less than 20% of losses globally are covered by insurance and almost 90% of losses are from floods and windstorms.[80]

In 2003, UNEP merged the Financial Institutions Initiative and the Insurance Industry Initiative into one program. The resulting Finance Initiative has over 200 members in 45 countries. In its 2002 report, the initiative found that economic losses due to natural disasters were doubling every decade and based on current trends will reach $150 billion per year within the next decade. The Climate Change Working Group has been established under the initiative to present to the financial sector the risks and opportunities climate change presents and urge them to play a key role in delivering market solutions that mitigate its effects. Exceptionally high premiums make it difficult for residents of developing countries to obtain insurance against natural catastrophes. One of the re-insurance company members has established a GHG risk solutions team to construct state-of-the-art solutions for risk transfer of carbon-related liabilities and carbon mitigation.

Decision makers in all areas find themselves confronted by radical changes in the risk landscape. Traditional risks are becoming even more complex, while new risks that are difficult to comprehend continue to arise. Epoch-making events such as the 9/11 attacks, severe acute respiratory syndrome, the December 2004 tsunami disaster, and the failure of power grids on several continents have led to a radical overhaul of risk assessment practices, particularly in companies. Today's risks have far wider implications for business and require a holistic approach linked directly to sustainable development.

To support governments, business, and other organizations in fostering public confidence in risk governance and in related decision making, the WBCSD helped set up the International Risk Governance Council. During its launch in Geneva in June 2004, the council explored risk issues from business management and national policy perspectives looking at challenges facing both industrial and developing countries. The WBCSD president stressed that, "…society lacks both the understanding and the institutional capacity to tackle the increasing systemic risks, which our modern complex world has led to." Companies in Asia and the Pacific have considerably greater exposure to such risks than their counterparts in the northern hemisphere.

Supply Chain Pressures

One of the most important drivers toward improved environmental performance may be peer pressure from other companies in the global supply chain (business-to-business or B2B). Company representatives at the workshops for AEO 2005 consistently referred to the importance of supply chain relationships in creating pressure on SMEs to improve their environmental performance. Large global corporations increasingly aware of risks to their reputations from errant suppliers are demanding that their smaller supply firms in Asia and the Pacific adopt one or more certification schemes and carry out regular audits.

For example, a well-known sports shoe company has over 750 contractors in more than 20 countries. Through their Sustainability Initiative, issues such as reduction of solid wastes and hazardous chemicals, sustainable product design and manufacturing, and product LCA have been addressed. A key element of this work has been the collection, validation, and reporting of key environmental metrics. The work has included developing a database, issuing reporting forms to factories, collecting quarterly data from factories, validating data, and generating quarterly corporate environmental reports. Box 3 highlights some lessons learned in working with SMEs to improve their environmental performance.

While poor product quality is probably the main reason for jettisoning an SME, there may be some cases where failure to meet environmental standards was a primary cause. The recent action of a large international bank to stop all lending to forestry companies in Indonesia and Malaysia exemplifies this principled stand. Initially, rejected companies may find alternative buyers or creditors (e.g., small local banks), but there will come a point at which such opportunities will dry up.

There are two types of supply chains: producer and buyer.: The automotive sector is an example of a producer chain and the clothing, footwear, and furniture sectors are examples of buyer-driven chains.[81] These supply chains are an increasingly important feature of the Asian and Pacific economic miracle. Do these new business partnerships foster a "race to the bottom" as pessimists fear or a "race to the top" as optimists hope? It is clear that MNCs with name and brand reputations to protect are under strong environmental pressure from customers, regulators, and investors to transfer OECD environmental and social standards to their suppliers in developing countries.[82] The MNC partner may be willing to transfer environmental technology and training to ensure that neither their suppliers nor they themselves are subject to environmental criticism. Thus, supply-chain partnerships have the potential for upgrading developing country enterprises. However, the market expects firms in Asia and the Pacific to make "first world products at third world prices," as one of the AEO workshop participants stated, and this places intense pressure on those firms.

Some observers suggest that there is a strong positive link between strict national environmental regulation and competitiveness.[83] The crux of this argument is that unilateral environmental regulation encourages domestic industries to innovate, generate first-mover advantages, and become leaders in the global economy. Environmental requirements by MNCs on developing country suppliers could have the same effect as national environmental regulations and trigger innovations. Thus, when MNCs require environmental upgrading from their suppliers, this would improve the relative competitiveness of those suppliers that successfully compete for the business. Many local firms continue to resist strict environmental regulation since they appear to impose costs with little or no immediate benefit to the firm. Correspondingly, some firms may resist or resent environmental requirements imposed by MNCs wielding their market power and offer only token compliance.

Copycat Environmental Legal Liabilities

Following the Love Canal incident in the US, Congress enacted the Superfund Law. Under the doctrine of joint and several liability, if the government found even one container of hazardous waste in an abandoned waste site bearing a company's name, it could hold that company liable for all associated clean-up costs and force the company to find and sue the other illegal disposers for recovery of their shares of the costs. This relieves the government from the complex process of discovery and allocation of liability among all the dumpers. Some may never be found. This law has generated a series of legal suits and actions against major corporations. Although the effectiveness of this law is highly disputed, there can be no doubt that it has imposed

Box 3: Working with Small and Medium-Sized Enterprises: Some Lessons Learned

Programs like the Samut Prakam Cleaner Production for Industrial Efficiency (CPIE) Project in Thailand (see Box 4) have identified a number of lessons learned in working with SMEs to improve their environmental performance. Some of these include:

Focusing on management capacity - While it is certainly important to provide information on available environmental technologies to industry, a significant and often overlooked barrier to sustained implementation of eco-efficiency measures is the lack of management capacity to plan, implement, evaluate, and follow up on these measures.

Taking a gradual approach - The CPIE project found that most factory managers are extremely skeptical about value of environmental measures and therefore unlikely to make big investments without fully understanding the benefits that CP can provide. Thus, it is wise to pursue a gradual approach, starting with low-cost or no-cost measures, followed by investments in cleaner technology, implementation of a certified management system, or even life cycle assessments much later.

Promoting self-inspection and self-auditing - Giving SMEs the management tools to develop and implement their own projects results in longer-term implementation of eco-efficiency measures and also reduces the cost burden for doing inspections and audits. Experience from the US has shown that a crucial part of this strategy is a preceding letter sent by the regulator, which implies that nonparticipants will be a high priority for inspection and, in the event of breach, enforcement action.

Using surrogate regulators - Sometimes government's capacity to regulate SMEs is very limited but there is a credible third party who may be harnessed to play a surrogate regulatory role. For example, substantial compliance was achieved in the Australian State of Victoria after the major vehicle insurer was persuaded to only contract with vehicle repairers, which complied with the state's "clean and green" initiatives.

Designing Neighborhood Environmental Improvement Plans (NEIPs) - Victoria also had success in improving compliance by designing NEIPs to foster local community involvement in and control over environmental issues relevant to their neighborhood. NEIPs are deliberately broad in scope in that they can apply to a range of environmental issues, and they are designed to facilitate the engagement of both residents and businesses.

Enlisting the assistance of trade and industry associations - These associations can play a valuable role in promoting benchmarking exercises within their sectors, generating motivation and competition.

Harnessing supply chain pressure - Larger firms may be able to impose product and process preferences on smaller firms, using their market power to influence the behavior of upstream suppliers and downstream buyers. In particular, some kinds of environmental purchasing, particularly the use of environmental surveys and audits of suppliers can strongly motivate the suppliers to improve their environmental performance.

Sources: The Greening of Industry Network. 1998. *Summary Report of International Forum on Greening of Small and Medium-Sized Enterprises.* Manchester, UK. http://www.greeningofindustry.org/summary.html; Gunningham, Neil. *Compliance, Enforcement and Innovation*. Australian

significant costs on business for actions taken over many decades. Similar legislation is now in force in several other OECD nations.

Environmental activist groups may lobby governments in Asia and the Pacific to enact similar legislation as the public becomes increasingly aware of hazardous wastes disposed of during the past 40–50 years (often without regard to whether that disposal was in compliance with the laws in force at the time). Companies that upgrade their current disposal practices will be limiting future liability. As part of their strategic planning processes, they might also closely monitor new environmental legislation emerging in OECD countries. Much of the environmental legislation now in force in Asia and the Pacific has been adopted from developed country examples.

Animal Rights Group

For companies involved in the use of animals in product testing or research and development, a further source of pressure may come from animal liberationists or animal welfare groups. Activists in the UK and the US have taken extreme steps to protect animals. In addition to nuisance picketing, some of these actions have included criminal attacks against private property and physical attacks against corporate executives. Companies involved in natural resource exploitation have also come under attack. For example, part of the campaign against whaling by Japan and other pro-whaling nations is because of the cruelty of using explosive-tipped harpoons. As increasing evidence emerges of animal intelligence and cognitive abilities, any corporation that does not pay attention to animal welfare may be targeted. In this context, different value sets regarding the rights of animals in developed and developing countries may come into play.

Animal rights activists are passionate in their views. Those opposed to inhumane transport of livestock have organized pickets and other protests that have forced shippers and buyers in Europe to modify transport rules and regulations. The issue of fox hunting became a major political controversy between the democratically elected House of Commons and the unelected House of Lords in the UK; the sport was ultimately banned in 2004. Many in the rural minority saw their historical rights eroded by an urban majority that had little understanding and even less sympathy with what urbanites believed to be an inhumane sport. Thus far, this has been a uniquely "British" issue, although cruelty to animals appears to resonate with affluent middle class populations around the globe.

Another controversial issue involves protests against the use of animal fur and products for high fashion. People for the Ethical Treatment of Animals has managed to recruit a number of high-visibility fashion models and well-known entertainers to participate in cleverly staged boycotts of fur coats and other fashion apparel using animal products. This campaign has attracted more radical activists willing to risk civil suit and arrest for throwing paint on expensive fur coats in acts of civil disobedience. It remains unclear whether this is a temporary phenomenon or an indicator of a sustained and growing campaign against the use of animal products for fashion apparel.

FINAL WORDS

A rapid expansion of environmental awareness and a range of external pressures to encourage stronger environmental management are coming to Asia and the Pacific. Not all of these pressures will have equal impacts on the region's corporate sector nor will they all strike at the same time. However, when the cumulative effects of these changes on the business climate are considered, a picture begins to emerge of how globalization and social change will fundamentally change the "rules of the game" for businesses in this region. These pressures all point to the same conclusion—the old ways of doing business are over. Companies in Asia and the Pacific must learn to assess and control corporate risk, move beyond mere compliance with government environmental and other regulations, and improve their internal governance. With the progression of the modern information age, it will soon be nearly impossible for businesses to hide behind national protectionism or to "fly under the radar," hoping that society and customers will ignore a company's operational practices. If companies do not accept and respond to the trends driving corporate accountability and responsibility for sound environmental performance, they will find themselves losing market share, access to capital, and the goodwill needed to operate in any society.

CHAPTER 3

Moving through the Regulatory Jungle toward Compliance

There are many drivers that determine whether and when a corporation will become "greener" and move toward compliance with environmental laws and regulations. Businesses can be attracted to improve their environmental performance by the "pull" of the market or by the "push" of drivers that are either external to firms or a function of internal production economics and company characteristics.

Governments in Asia and the Pacific have often found it difficult to encourage firms to comply with existing environmental regulations. However, the types of global pressures described in Chapter 2 are likely to push corporations to rapidly move toward compliance and even beyond. Though there are some policy adjustments that can help, the region's governments will probably follow in the wake of these external pressures rather than lead them. Corporations already face a formidable range of existing and developing laws, regulations, and standards, and they can expect these to tighten in the future. These are emanating from (i) subnational and sector goals and targets; (ii) national environmental laws and standards; (iii) commitments that governments make to global and regional agreements; and (iv) industry-led "new regulation" or quasi-standards.

Environmental compliance has traditionally been defined as a corporation attempting to meet performance standards laid down in law by a government regulatory authority. In such a command-and-control regulatory context, standards often dictate specific effluent or emission reduction technologies for a given production process. For example, a license to operate a coal-fired power station may require scrubber technology to be installed to catch particulates before they reach the end of the stack in order to meet specified emission limits. The limits for each pollutant are usually based on scientific predictions of impacts to human health or on estimates of ambient pollution levels that can be accumulated by the natural environment, though in practice these have largely been borrowed from North America or Europe and applied in Asia and the Pacific without adjusting them to local conditions. Corporations comply when they meet the conditions specified under their operating licenses. This traditional view of compliance has corporations meeting standards as designed by independent regulators—a system transplanted from the developed-country model first implemented aggressively in the late 1960s and early 1970s especially in North America and Europe.

While this approach has met with considerable success in controlling "end-of- pipe" pollution problems in developed countries, it has not been without its difficulties. It may not be the best approach to improving the environmental performance of corporations in Asia and the Pacific as firms in the region generally have not met the compliance targets set through this traditional method. Continued environmental degradation associated with the region's rapid economic growth has been the result.[84] This lack of compliance appears to be due to a range of factors such as (i) lack of regulatory resources to enforce standards; (ii) uncertain laws, with few penalties for noncompliance;

(iii) corruption; (iv) inadequate laboratory facilities and an inability to collect evidence that is reliable enough to secure a prosecution; and (v) lack of information about laws and clean technologies.[85] In much of Asia and the Pacific, environmental agencies do not have enforcement powers and must rely on ill-equipped and poorly trained police forces to apprehend and prosecute polluters as well as those abusing natural systems such as illegal loggers and poachers.

Multiple "Licenses" to Operate

While regulators will always want corporations to meet environmental performance standards, a tentative response to the problems of the traditional command-and-control regulatory approach is beginning to present itself in Asia and the Pacific. This response is based on the idea that some corporations—especially the larger ones with international markets—are starting to think of their "licenses to operate" as having three prongs: regulatory, economic, and social. In the past, if a corporation had all of its government approvals and operating permits, then it was considered to have met the demands of the regulatory license.

A more contemporary view is that corporations need two additional kinds of licenses to operate in the modern world: an "economic license" that requires meeting rate-of-return targets and debt obligations and a "social license" provided by significant stakeholders (and in particular, local communities).[86] Of the three, the social license is the least precisely defined and may be the hardest to obtain. However, ignoring the demands of community neighbors or environmental groups can result in significant damage to the reputation of a firm and/or its key brand(s), repeated complaints to the authorities, and consequent direct loss of sales and/or calls for tougher regulation. Because the demands of the social license can be tougher than an existing regulatory license, this can sometimes push firms to move beyond compliance. The response to this social license is now commonly referred to as part of "corporate social responsibility" or CSR.[87]

"New Regulation"

The recognition of the need for a social license to operate has resulted in very different ways of thinking in government circles about how to get corporations to perform. For example, private standards have been developed where corporations in a similar industrial sector band together to establish tougher environmental performance conditions (by way of a voluntary code) than previously existed.

The "new regulation" tools now being considered and increasingly utilized center on (i) education, (ii) providing information, and (iii) voluntary measures. Education tools attempt to alter behavior through formal and informal learning. This can range from public programs of moral suasion on issues such as recycling and using public transport to corporate attempts to encourage employees to generate eco-efficient innovations. Providing information is less didactic, focusing instead on initiatives such as the transparent publication of emission data and the public availability of corporate performance ratings. Examples of the former include the Toxics Release Inventory in the US, and the National Pollutant Inventory in Australia. Sometimes these initiatives are termed the "public or environmental right-to-know."[88] Examples of the latter include independent audits and the Program for Pollution Control, Evaluation, and Rating (PROPER) in Indonesia, a pollution database.[89] Building on cultural characteristics of "saving face," the mere prospect of being named and shamed in public can often motivate firms to "voluntarily" change their behavior, and a number of voluntary pollution reduction partnership arrangements have emerged in recent years though the majority have been in Europe.

Providing information lies at the core of what is becoming known in developing-country environmental policy as "informal regulation." Informal regulation includes efforts to monitor and publicize emissions but also includes activities such as organized demands for compensation, social ostracism, and threats of physical violence.[90] New empirical research in PRC, Colombia, India, Indonesia, Mexico and Philippines shows that where formal regulation (meaning command-and-control) is weak or absent, informal regulation through local community participation can lead to more effective pollution abatement.[91]

The third and final category of new regulation is voluntary agreements (VAs). These include those made between regulatory agencies and corporations (which can be either non-binding or negotiated legal contracts) among firms in an industrial sector and unilateral commitments by firms to meet a certain standard or to carry out a particular practice.

Sorting out the compliance jungle begins by outlining the pressures from traditional regulatory sources that are defining the basic compliance standards that corporations in Asia and the Pacific must meet. The sorting process ends with more detailed explanations of these new regulations.

SUBNATIONAL AND SECTORAL GOALS AND TARGETS

There is a wide range of subnational and sector goals and targets embedded in various policy and planning instruments including national forestry action plans, sustainable agriculture plans, industrial sector plans, and provincial and watershed development plans. As this field is comprehensive, only a selection of the key approaches is dealt with here.

Claimed as one of the greatest results of UNCED, local Agenda 21 plans have been prepared throughout Asia and the Pacific. At the 1992 summit, each local authority was called upon "to enter into a dialogue with its citizens, local organizations, and private enterprises and adopt a local Agenda 21." As the bulk of the region's population is likely to be located in cities, it may be assumed that local plans will generate rules and standards that may be of importance to corporate considerations of their obligations in relation to the environment. Indeed, the original resolution at UNCED went on to say, "Local authority programmes, policies, laws, and regulations to achieve Agenda 21 objectives would be assessed and modified, based on local programmes adopted."

By 1997, 170 local Agenda 21 plans had been produced in Asia and the Pacific, and the Asia Pacific Economic Commission (APEC) had called for the number to be doubled by 2003. In a December 1998 survey, the International Council for Local Environmental Initiatives found that over 300 local governments had completed or were undertaking local Agenda 21 plans. The range of actions included under these plans is as diverse as the cities themselves.

For example, Shiga Prefecture in Japan, with a population of 1.4 million, has tackled the growing pollution, exotic species invasion, and red tides in Lake Biwa through the creation of sub-basin councils. Each council is required to set goals and targets and to develop a plan of action for part of the watershed draining into Lake Biwa. In Nagoya City, Japan, the 2.2 million residents generated 1 million tons of solid waste per year and faced a waste crisis when a proposed landfill did not proceed and the city's incinerator was shut down. The 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 1 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.

The city of Melbourne, Australia (population 3.4 million) has developed a "zero net emissions by 2020 strategy" that will appropriate 800,000 tons of carbon dioxide emissions, increase renewable energy by 22%, and achieve a 50% improvement in energy efficiency. Sendai City in Japan is implementing a systematic and comprehensive green procurement program. The product groups defined in 2003 were paper, printing paper, sanitary paper, stationery, office furniture and supplies, office automation equipment (such as personal computers, photocopiers, and fax machines), home appliances, lighting, uniforms and work wear, interior and bedroom goods, work gloves, textile products for sports/events/outdoor (including tents and tarpaulins), automobiles, and materials for public works, facilities, and services. The proportion of "green" to traditional items was set at 90% for the entire city, generating considerable incentive for producers to change their product mix.

It is not only governments that have prepared sector plans for environmental management. In 1997, Japan's Keidanren (Association of Industries) produced its Voluntary Action Plan on the Environment encompassing specific plans for their various sectors and their industry associations.[92] The voluntary plan focuses on measures to combat global warming and to improve waste disposal. Many industries set quantitative targets and 2010 as their target date to achieve their objectives. The sector plans are not binding nor are they formal agreements with government. In some respects, the plans resemble private voluntary agreements described later in this chapter. Because they are "aspirational" plans, there are no penalties for noncompliance, only peer pressure from other association members.

NATIONAL ENVIRONMENTAL LAWS AND STANDARDS

National standards and policies remain the most important influences on corporate compliance because it is at this level that laws and behavior can be enforced. 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 activity). Within these categories, governments attempt to influence how new developments are designed (e.g., through the EIAs and other approval mechanisms), how pollution is controlled, and how natural resources are managed.

Until recently, most of these approaches to setting environmental standards were copied from developed countries. This applied to both "process" standards (related to approving new developments) and "output" standards related to pollution. In more recent times, developing countries have begun to amend these standards to make them more specific to their own circumstances.[93] Often the "adopted" standards could not be enforced because local laboratories were not sophisticated enough to measure the minute levels of pollutants embodied in developed-country standards.

As standards are being tightened in developed countries, the region is fast catching on. A recent example is the commitment made by the Government of Singapore to tighten air pollution regulations to meet Europe's "Euro-4" fuel standard. This will reduce permitted poisonous emission levels by half.[94] To meet this standard, many of the world's carmakers are adding complex filtering systems to diesel engines to reduce tiny particulate pollutants of 2.5 microns or less that are small enough to bypass the human body's regulatory defense system. The PRC is also enforcing a much tougher standard on fuel economy. To be introduced in two stages, the new standard will in the end be slightly more stringent than US fuel economy regulations. Some vehicle manufacturers may require higher capital expenditures to meet these tighter standards.[95]

Such regulatory developments are underpinned by new scientific research showing that much lower levels of pollution than originally thought can damage health. In some cases, there may be no safe limit. In addition, new technology is now able to measure increasingly minute quantities of pollutants. One outcome of these twin developments is that the pressure for environmental standards to tighten is likely to continue to increase. For new industrial plants, it is necessary, therefore, to design for tomorrow's standards not for today's, as the plants may still be operating in 30–40 year's time and by then almost certainly the standards will have been tightened. Retrofitting to meet new standards can be much more expensive than allowing for significant over-compliance in new plant designs.

However, mere tightening of environmental standards implemented through traditional command-and-control regulation will not necessarily result in improved compliance rates in Asia and the Pacific. This is due to a combination of lack of enforcement, corruption, weak courts, and lack of access to information.

A good example is the control of vehicular pollution in Delhi, India. Over the past 20 years, the regulation suffered from weak enforcement by government agencies. Then an NGO petitioned the court to force the government to implement the 1981 Air Act.[96] Actions taken by national and local governments included policy changes announced in 1989–1990 on increasing penalties and tightening emission standards, but these again failed due to lack of monitoring and testing equipment. Over the period 1994–1998, the court forced the government to implement policies that had "died on the vine," including the phaseout of leaded gasoline, use of premixed fuels for two-stroke engines, and the phaseout of 15-year-old vehicles. Frustrated with the slow pace of implementation, the Supreme Court issued a notice ordering the Government of Delhi to submit an action plan to control the city's air pollution. Both local and national governments prepared comprehensive plans in 1996 and 1997, respectively.

Using the 1997 plan as a trigger, the Court then directed the Ministry of Environment and Forests to use its authority under the Environment Protection Act to establish a committee—the Environment Pollution (Prevention and Control) Authority—to monitor implementation of the plan and to suggest other policies to control pollution. With a mandate from the court and under inspired leadership, this authority became a powerhouse recommending even more drastic measures including shifting the entire bus fleet to compressed natural gas (CNG) by March 2001. As the deadline approached, only about 25% of the old buses were allowed on the roads, leading to riots in the streets by frustrated commuters. An extension to the conversion order was granted until March 2002. In April 2002, the Supreme Court directed the immediate installation of 1,500 CNG buses and replacement of 800 diesel buses per month. Any diesel bus operator ignoring the order was subject to a heavy fine. Nearly half the bus fleet (7,000 diesel buses) was forced off the road. By December 2002, all diesel buses had been converted to CNG. Based on the success in Delhi, similar initiatives were started in Bangladesh, Nepal, Pakistan and Sri Lanka—often with less effective outcomes. It may be argued that reliance on an independent judicial body to enforce the laws rather than on the mandated government agency does not bode well for command-and-control regulations in the region.

Another interesting approach to forcing compliance in Asia and the Pacific is through the use of what has become known as "informational regulation."[97] Governments either encourage or require information about environmental impacts to be provided to the public. For example, in the PRC in 1997,

SEPA initiated the Weekly Air-Quality Status Report Program through local media in 13 key cities. The Daily Air Quality Status Report Program covering 47 key cities is presented on closed-circuit television and in major national newspapers. Public disclosure may be encouraged through corporate environmental reporting or may be required through environmental "right-to-know" laws.

A well-known variation of the required right-to-know approach is Indonesia's PROPER program. Launched in 1995 by the country's Environmental Impact and Management Agency (also known as BAPEDAL which stands for *Badan Pengengdalian Dampak Lingkungan*), the program has created culturally sensitive incentives for compliance through "honor and shame."[98] In the trial phase, BAPEDAL developed a priority list of 187 water polluters that were required to negotiate pollution control agreements with regulatory teams (with the involvement of environmental groups). Regulators then ranked the performance of facilities using past emission information, self-reporting, and independent audits. Enterprises were ranked in a color-coding scheme that was easy for the public to understand (gold and green for the best performers, black, blue, and red for those not in compliance). The ranking information was released to the public; good performers were praised publicly and poor performers were given time to clean up before public disclosure.

Evidence from evaluations indicates that this trial program was very successful reducing pollution by over 40% in the trial group of 187 between December 1995 and July 1997. By the end of this period, more than half of the plants were in compliance (compared with only one third at the start of the program). Primary research indicated that the key factor in spurring pollution abatement (and the move toward compliance) was information dissemination, that is, improving factory managers' knowledge about their own plants' emissions and abatement opportunities. This contrasts with the prevailing view that external pressure from community groups and other stakeholders is what drives improvement, although it should be noted that the research showed that both drivers work together to improve performance.[99]

PROPER fell into decline in the late 1990s when BAPEDAL was disbanded. However, it has recently been restarted with company participation increasing from 84 in 2002 to 466 in 2004. Participation is expected to reach 1,750 by 2008.[100] The initial success of PROPER has led to tentative trials in other countries, most notably the Philippines and Thailand; however, as an essentially "political" process, it has often fallen afoul of political interference by well-connected businesses. In societies where corruption remains prevalent, some businesses can subvert and undermine command-and-control regulation as well as voluntary agreements. Firms can pay public relations people to stretch the truth, bribe third-party verifiers, and offer incentives to subservient media. The solution lies in tackling corruption at its roots and in adopting environmental policy measures that are realistic and efficient in terms of their enforcement and compliance costs.

National Environmental Strategies

Another source of national influence on environmental standards is a series of instruments generally known as "national environmental strategies." These sometimes have the force of law and may be backed by new institutional arrangements, but in many cases they are influential instruments of policy. Some of these approaches focus narrowly on environmental issues and others are broader and deal with the integration of environmental, development, and social concerns. They are being mainstreamed into economic development plans and poverty reduction strategies through an evolutionary process similar to the progressive improvements in EIAs over the past two decades. They fall into the following categories:

- national environmental action plan (NEAP);
- national sustainable development strategy (NSDS);
- national conservation strategies and/or biodiversity action plans;
- documents that contribute to the strategic process of identifying and responding to environmental problems such as country environmental profiles and state-of-the-environment reports.

Where environmental issues have been sufficiently integrated or mainstreamed into regular economic analysis and planning, stand-alone national environmental strategies are not needed. To some extent, NSDSs can be integrated, but generally they still tend to sit outside of traditional economic planning.[101] The rest of this section discusses the relationship between the most influential of these strategy types (NEAP and NSDS) and evolving environmental compliance standards.

Since the mid-1980s, international development agencies and NGOs have been helping developing countries to prepare NEAPs. In 1990, the World Bank initiated a program to assist International Development Association borrowers to complete their NEAPs; by the mid-1990s most borrowers as well as developed countries had prepared national environmental plans. Most NEAPs have similar objectives and attempt to analyze the environmental impacts of macroeconomic and sector policies, programs, and projects.

World Bank reviews of NEAPs have indicated that three elements are crucial: (i) prioritizing problems; (ii) proposing actions; and (iii) monitoring their implementation.[102] The last two elements tend to result in the selection of policies and instruments to deal with problems and the identification of legal and institutional reforms to tackle them. Table 2 provides some significant examples of national environmental strategies that have been instrumental in leading to new compliance requirements, many of which are directed toward corporations.

According to a World Bank review of 30 NEAPs undertaken in 1995, categories of policies and instruments proposed by countries tend to include: (i) awareness building (88%), (ii) regulatory instruments (85%), (iii) market-based approaches (58%), (iv) property rights (27%), and (v) direct investments (24%). The review showed that implementation relies heavily on legislative reform and emphasizes command-and-control instruments. However, it already has been noted that traditional regulatory instruments require strong institutions to work effectively, and these are often missing in Asia and the Pacific.

A small number of countries has addressed this issue by promoting "new" regulatory approaches in their national environmental strategies. Probably the best-known example from the developed world is the Netherlands' NEPP. The approach is unusual because it requires private sector groups to enter into voluntary agreements (covenants) to implement specific sector environmental objectives and targets, to audit the implementation of environmental management plans, and to prepare annual environmental reports. Over 100 covenants have been signed between the Government of Netherlands and industry.[103] The covenants, "…address both collective and sector-wide environmental issues and are legally binding on individual enterprises through the permit system, and are thus intimately linked to mainstream command-and-control regulatory standards."[104]

A good example is the Dutch Third Packaging Covenant, a pact between the packaging industry and the government signed by 250 companies.[105] The covenant commits the enterprises to increase their paper and board collection rate to 75% of total consumption. Under the agreement, enterprises draft environmental plans for each of their plants, identify environmental targets, and devise strategies to meet them. These targets are set at a level intended to collectively meet the objectives stated in the NEPP.

Table 2: Selected Examples of Linkages between National Environmental Strategies and Compliance Requirements

INITIAL STRATEGY	CONSEQUENT OR LINKED OUTCOME	COMPLIANCE REQUIREMENT
Bangladesh		
National Environmental Action Plan (1991)	National Conservation Strategy of Bangladesh (1991) National Environmental Policy (1992) National Environmental Management and Action Plan (1992)	Establishment of environmental units in line Ministries Establishment of an EIA system Establishment of polluter-pays principle Numerous laws to combat industry-related pollution problems
Nepal		
National Conservation Strategy (1989)	National Biodiversity Action Plan (not complete at time of writing)	National EIA Guidelines (1993) Environmental Protection Act (1997) - establishment and enforcement of pollution standards - legal backing for EIA guidelines
Pakistan		
National Conservation Strategy (1992)	Ninth Five-Year Plan (1998)	Environmental Technology Programme for Industry National Environmental Quality Standards Industry sector-specific pollution control projects
Cambodia		
National Environmental Action Plan (1998)	Governance Action Plan (2001) Second Five-Year Socioeconomic Development Plan (2001) National Biodiversity Strategy and Action Plan (2002)	1993 Royal Decree on the Creation and Designation of Protected Areas 1996 Law on Environmental Protection and Natural Resource Management 1999 Subdecree on Water Pollution Control 1999 Subdecree on Solid Waste Management 1999 Subdecree on Environmental Impact Assessments
Mongolia		
National Environmental Action Plan (1995)	National Plan of Action to Combat Desertification Biodiversity Conservation Action Plan National Plan of Action for Protected Areas Mongolian Action Program for the 21st Century (MAP-21)	Law on Environmental Protection (1995) Law on EIA (1998) 23 laws, regulations, or standards governing use of water resources 41 laws, regulations, or standards governing use of forest resources 19 laws, regulations, or standards governing toxic chemicals 20 laws, regulations, or standards governing use of mineral resources 18 laws, regulations, or standards governing protected areas
Maldives		
National Environmental Action Plan (1990)	Second National Environmental Action Plan (1999)	Environmental Protection and Preservation Act (1993) and associated regulations dealing with environmental impact assessment, waste management, protected areas designation and management Amendment of the Fisheries Law of Maldives

continued on next page

Table 2 continued

INITIAL STRATEGY	CONSEQUENT OR LINKED OUTCOME	COMPLIANCE REQUIREMENT
Kazakhstan		
National Environmental Action Plan (1997)	National Action Plan to Combat Desertification (2002) Strategic Water Resources Plan National Drinking Water Action Plan Energy Strategy	Law on Environmental Protection Law on Energy Saving Law on Air Pollution (2002) Law on Ecological Expertise Large-scale land use zoning
Kyrgyz Republic		
National Environmental Action Plan (1995)	National Program of Agricultural Development	Law on Environmental Protection (1999) Law on Ecological Expertise (1999) Law on Waste Production and Consumption (2001) Law on Tailings Ponds and Dumps (2001) Land Code (2003) Law on Drinking Water (2003) Law on Fisheries (1998)
Tajikistan		
Draft National Environmental Action Plan (1999) State Environmental Program (1997)	National Program of Action to Combat Desertification (2002) Strategic Plan of Sustainable Development National Action Plan on Environmental Hygiene and Health (2000) National Strategy and Plan of Action for Biodiversity Protection and its Rational Utilization (2003)	EIA Law of 2003 Law on Waste, Waste Generation and Waste Utilization (2002) Water Code (2002)

Sources: (i) ADB 2004. *Kyrgyz Republic: Country Environmental Analysis.* Manila; (ii) ADB. 2004. *Kazakhstan: Country Environmental Analysis.* Manila; (iii) ADB. 2004. *Cambodia: Draft Country Environmental Analysis.* Manila; (iv) ADB. 2002. *Mongolia's Environment: Implications for ADB's Operations.* Manila; (v) ADB. 2000. *Bangladesh: Toward an Environment Strategy.* Manila; ADB. 2004. *Country Environmental Analysis: Tajikistan.* Manila; and (vi) Dalal-Clayton, Barry, Krystyne Swiderska, and Stephen Bass. 2002. Stakeholder Dialogues on Sustainable Development Strategies: Lessons, Opportunities, and Developing Country Case Studies. *Environmental Planning Issues 26.* London: International Institute for Environment and Development.

An example of a developing country national environmental strategy that makes provision for greater private sector participation in environmental policy is Thailand's Policy and Prospective Plan for the Enhancement and Conservation of National Environmental Quality (1997–2016). The plan proposes the establishment of a "participatory environmental management committee" aimed at (i) promoting the adoption of cleaner production practices, (ii) the provision of technical and financial assistance for the implementation of EMS, and (iii) the adoption in cooperation with business groups of an EcoWatch "environmental right-to-know" program.[106]

An NSDS is a national strategy that may have a direct impact on environmental standards and thereby influence the performance of corporations. Called for by Agenda 21 to be completed in each country by 2005, NSDSs are developed through participatory processes to achieve economic, environmental, and social objectives in an integrated fashion. Nearly all countries in Asia and the Pacific have some form of NSDS, although the quality of these strategies varies. Since 1994, more than 140 countries have submitted such reports to the UN Commission on Sustainable Development.[107]

Two examples from the region show the link between NSDSs and corporate environmental performance. In the PRC, the State Council has approved a comprehensive environmental plan to support its Agenda 21, the main features of

which are: (i) enforcing a total load control policy to maintain pollution from industries at 1995 levels; (ii) increasing pollution levies to equal or exceed waste treatment costs; (iii) increasing the use of market-based economic and financial instruments such as environmental taxes or tradable permits; (iv) promoting the use of clean production technology; and (v) adopting the Trans-Century Green Project.

The environmental plan for the tenth 5-year period (2001–2005) emphasized eight aspects: (i) ecological protection will be accorded equal importance with pollution, (ii) cleaner production, (iii) pollution control will be further promoted for industrial pollution abatement, (iv) sustainable urban development, (v) environmental protection of agriculture, (vi) nuclear safety, (vii) institutional strengthening, and (viii) transboundary and international environmental issues. The plan aimed to prevent pollution at the source rather than to treat it at the "end of the pipe," and it viewed environmental improvement and economic growth as a win-win combination. The eleventh 5-year plan both continues and seeks to accelerate these approaches.

To ensure implementation of these plans, the PRC has implemented wide-ranging regulations and standards. By 2003, the legal framework consisted of nine laws on environmental protection, 24 laws on natural resource management, 34 administrative rules and regulations, and 427 standards for environmental protection.[108] SEPA and its provincial and municipal counterparts supervise monitoring of polluting corporations, although mostly they rely on self-reporting supplemented by random supervision checks. Local environmental supervision bureaus have teams responsible for environmental law enforcement and collection of pollution levies. Many of the worst polluters have been forced out of business. Highly ranked firms have been cited as "national excellence enterprises for environmental protection" and "national environmental protection advanced enterprises."[109]

It is a useful contrast to examine how one of the region's developed countries deals with the role of the private sector in attaining its national environmental objectives. Japan prepared its National Action Plan on Agenda 21 in 1994.[110] In its national assessment prepared for WSSD in 2002, Japan noted that one of its best achievements was that "business operators have made progress by launching voluntary activities, obtaining ISO-14001 certification, introducing environmental accounting, and compiling/publishing environmental reports."[111] In addition, the national assessment states that, "…we must give up the practices of mass production, mass consumption, and mass disposal by our current society and start to put into place a legal system that will enable us to build a society with a sound material cycle, that has low environmental impact and that is sustainable." In this respect, a basic law for establishing a recycling-based society was passed in May 2000. A pollutant release and transfer register system has also been introduced. Other laws on global warming, the rational use of energy, promoting new sources of energy, eco-friendly procurement by the state, and access to information and sustainable agricultural practices provide a comprehensive suite of laws to guide society toward sustainable development.

This brief review of national environmental strategies has pointed to the influence that these initiatives can have on environmental legislation and performance standards and thereby on corporations' freedom to operate. Corporations in Asia and the Pacific should take an active role in formulating national environmental strategies, so that the blend of environmental policy instruments chosen will create appropriate incentives and opportunities for their improved environmental performance.

GLOBAL AND REGIONAL TARGETS DRIVING NATIONAL STANDARDS

Global Targets

The development of environmental standards in national jurisdictions should be intimately linked to international environmental governance. Countries rarely develop environmental laws and regulatory approaches without reference to the wider world. Without the benefit of the extensive research capacity needed to define appropriate environmental standards, developing countries usually look to developed countries for guidance when first setting national standards. In the absence of better information, they frequently have copied developed-country laws, regulations, and standards—often unaware that the developed country actually started with much less stringent controls. Hence, recent developments in environmental standards around the world will continue to influence national regulation and consequently the operations of firms in Asia and the Pacific.

This applies directly to approaches taken at the national level for the implementation of obligations under multilateral environmental agreements. A key environmentalist outlined how the process is intended to work, by using the Montreal Protocol for control of ozone-depleting substances as an example:[112]

Stage 1: Problem identification, fact-finding, and agenda setting. Concern about ozone depletion was initially triggered by concerns over exhaust emissions from supersonic aircraft followed by research in 1974 that showed that chlorine-forming compounds could deplete ozone in the stratosphere. In 1977, several countries asked UNEP to conduct fact-finding and to define the issue, thus moving it onto the international agenda.

Stage 2: Negotiation, bargaining, and agreement on what action to take, usually at the level of broad goals and institutional arrangements. For ozone depletion, UNEP called for international negotiations in 1981. In 1984–1985, the National Aeronautics and Space Agency (NASA) coordinated an international scientific review, thus making a powerful case for action. The framework convention followed in 1985 and established a convention of the parties and a UN secretariat. The negotiations that led to the Montreal Protocol started in 1986. Despite initial resistance from many affected businesses, the discovery of a huge hole in the ozone layer over the Antarctic gained public attention and demanded resolute action by governments.

Stage 3: Formal adoption. This usually requires a minimum specified number of countries to ratify the treaty.

Stage 4: Implementation, monitoring, and assessment, leading to further strengthening. The Conference of the Parties has continually strengthened the Montreal Protocol. If developing countries reduce their emissions, then the ozone layer should recover by 2050.

Unfortunately, the Montreal Protocol was more a product of good fortune (an affordable technological option became available), and is not necessarily proof that MEAs lead to tough enforcement at the national or global levels. Some activists question the value of MEAs in solving local problems. Their views are characterized by claims that a preoccupation with international legal treaties to address global environmental degradation instead of efforts to address root causes has, "…wasted much of the 20 years [that] could have [been] spent preparing for action."[113]

Despite limitations in rallying local action around global problems, international environmental law remains the global environmental community's weapon of choice, and national environmental laws and standards often draw from the same well. There has been an impressive expansion in MEAs over the course of the last 15 years.

MEAs developed as a public policy tool because countries working alone could not solve environmental problems that do not respect national boundaries. Most countries have now entered into several international environmental agreements, many of which have produced global environmental standards.[114] Perhaps the most significant and far-reaching of these agreements are (i) the UN Framework Convention on Climate Change and its Kyoto Protocol, (ii) the Convention on Biological Diversity, (iii) the Montreal Protocol on Substances that Deplete the Ozone Layer, (iv) the UN Convention on Combating Drought and Desertification, and (v) the Convention on Long-Range Transboundary Air Pollution. Though the process has been slow, the interaction of these types of agreements has progressively and incrementally raised environmental, health, and safety standards at the national level. Thus, in turn, it is having an impact on the national and international policy climate faced by the private sector.

It is generally understood in international law that "hard law," as agreed in treaties, is legally binding on the parties (i.e., countries) that ratify them. In practice, this means that if a country ratifies a treaty, then it must implement the conditions of the treaty in corresponding domestic law. Many national environmental laws only exist because countries have ratified treaties and were subsequently required to implement them. By extension, where a treaty specifies an environmental standard of some kind, it must eventually find its way into national law. An example of this rule is the Renewable Energy (Electricity) Act 2000 of the Government of Australia that is in part a mechanism for implementation of the UN Framework Convention on Climate Change and requires energy utilities to obtain 2% of their electricity from renewable sources by 2010. Similarly, in 1997 Japan approved a law concerning special measures for the promotion of new energy use and in 1998 a law concerning the promotion of measures to cope with global warming (subsequently amended in 2002) and an amended law concerning the efficient use of energies. If voluntary commitments by industry are not sufficient to reduce emissions of GHGs, then the Government of Japan is also holding out the threat of a future environmental tax.

Several countries in Asia and the Pacific have prepared legislation or implementing rules to implement their commitments under the Montreal Protocol. For example, India has drafted Ozone Depleting Substances (Regulation) Rules under the Environment Act covering the production, sale, consumption, export, and import of ozone-depleting substances. Singapore used a tender and quota allocation system that distributed a limited quantity of the substances to companies with the highest replacement costs and sent a strong market signal to look for alternatives, conservation measures, and recycling. From 1992–1996, Singapore also introduced legislation to prohibit the use of halons in fire extinguishers, the import of equipment using chlorofluorocarbons (CFCs), and the import of CFCs, carbon tetrachloride, hydrobromofluorocarbon, and methyl chloroform.

Standards produced in international hard law can be either "content-focused" or "process-focused." Brief examples of content-focused standards include the following:[115]

- the 1985 Helsinki Protocol to the Geneva Convention on Long-Range Transboundary Air Pollution that required parties to reduce sulfur dioxide emissions by at least 30% by 1993 using 1980 levels as the basis for reduction calculations;
- the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer that required parties to phase out the production and consumption of CFCs by 2000;
- the 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change that requires developed-country parties to reduce overall GHG emissions by different percentages using 1990 as the basis for reduction calculations;[116]
- the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes that requires parties to set emission levels for discharges from point sources into surface waters based on best available technology and to define water-quality objectives and criteria.

Several global treaties have important implications for the corporate sector. Out of 45 countries in the region, the maximum number of signatories is 44 for the Convention on Biological Diversity, UN Convention to Combat Desertification and Framework Convention on Climate Change, and the minimum is 8 for Prior Informed Consent and Persistent Organic Pollutants. Other natural resource-related MEAs such as the Convention on International Trade in Endangered Species and the Ramsar Wetlands Convention also have relatively few signatories from the region. There has been no systematic effort to determine how many of these agreements have been followed by legislative or regulatory changes at the national level.

Process-focused standards tied to MEAs also are numerous. Some relate to the evolution of a duty to inform states that might be affected by the creation of a source of new or increasing pollution. The tool most often prescribed for this purpose is an EIA; some of the treaties that mandate one include the (i) UN Framework Convention on Climate Change, (ii) Convention on Biological Diversity, (iii) the Espoo Convention on EIA, (iv) all UNEP regional seas conventions, (v) Association of Southeast Asian Nations (ASEAN) Agreement on the Conservation of Nature and Natural Resources, and (vi) UN Convention on the Law of the Sea.

These international treaties, among other motivations, have driven domestic legal systems to feature EIA as an indispensable tool. There are direct implications for the environmental performance of corporations as EIA approval and costly mitigation measures are often legally required before regulators will approve new developments.[117] More recently, tentative moves have been made to extend EIA above the single-project level to examine cumulative or multiproject impacts and even sector-wide or policy impacts.[118] Environmental management plans, an essential component of EIAs, are also being extended into decommissioning or land rehabilitation plans where appropriate essentially extending EIA into LCA. EIAs may also call for environmental monitoring by independent third parties to ensure that mitigation measures are not only implemented but also are effective.

Another process-focused standard is the "precautionary principle." This effectively places the burden of proof on corporations to show that where an intrinsically serious risk of harm exists, a proposed project or new technology is only acceptable if adequate assurances can be given that adjustments can be made to prevent that risk from materializing. Treaties that include references to the precautionary principle include the (i) UN Framework Convention on Climate Change, (ii) Treaty Establishing the European Community, and (iii) Protocol to the Convention on the Prevention of Marine Pollution by Dumping.

Numerous environmental standards are also presented in nonbinding instruments of international law known as "soft law." The environmental field has generated a considerable amount of soft law in the form of "declarations," "recommendations," "accords," "codes of practice," and "guidelines."

Perhaps the most influential articles of soft law in terms of the development and promulgation of global environmental standards are (i) Agenda 21 from the 1992 UNCED, (ii) the Millennium Declaration and MDGs put forth in 2000, and (iii) JPOI, which emanated from WSSD in 2002. Agenda 21 was one of the first environmental declarations with very specific recommendations for the private sector.[119] The Millennium Declaration resulted in governments and organizations across the globe (including ADB) committing to the

eight millennium goals, including one goal and three targets on the environment.[120] JPOI reaffirmed the global commitment to Agenda 21 principles, the full implementation of Agenda 21, the MDGs, and the Programme for the Further Implementation of Agenda 21.[121]

While these soft law instruments are not legally binding, they still have substantial influence in international politics and national policies and hence affect the operations of firms. For example, the Yangon Resolution on Sustainable Development signed by the 10 ASEAN environment ministers in 2003 specifically refers to JPOI (as a framework for international and regional cooperation) and the MDGs. Soft law instruments also drive many of the funding priorities of bilateral and multilateral development agencies though they have occasionally been criticized as too time consuming and costly for small, developing states thereby detracting from the "real" work of environmental agencies.[122] Nevertheless, soft law has often been followed by hard law at the international level (e.g., the 1948 Universal Declaration of Human Rights was followed by the 1966 Covenants on Human Rights and numerous other human rights conventions[123]). Anticipating a similar progression from soft to hard law, the World Conservation Union's Commission on Environmental Law and the International Council of Environmental Law have been working since 1985 on a draft international covenant on environment and development that would consolidate existing legal principles.[124] Debate over the promulgation of such a unified convention also has been tied to UN reform issues, specifically the question of whether a UN environment organization should be formed to coordinate the implementation of existing treaties and a unified convention.

As the most recent soft law instrument, JPOI recognizes concerns over globalization and agrees that there is a need for the private sector to operate within a transparent and stable regulatory regime that reinforces corporate responsibility and social contribution. While most of their implementation measures are aimed at governments, both Agenda 21 and JPOI set out the following broad goals and targets specifically for corporations:

(i) contribute on a voluntary basis to a world solidarity fund to eradicate poverty;
(ii) pursue a 10-year framework to accelerate the shift of production and consumption to a more sustainable pattern;
(iii) increase investment in eco-efficiency and cleaner production;
(iv) reduce the flaring and venting of gas associated with crude oil production;
(v) enhance corporate environmental and social responsibility and accountability through voluntary initiatives such as EMS, codes of conduct, certification, and public reporting on environmental and social issues;
(vi) develop and disseminate innovative technologies for the key sectors of development, particularly energy;
(vii) promote private sector investment in sustainable agriculture;
(viii) enter into partnerships to achieve sustainable forest management;
(ix) provide financing and technical assistance for developing countries and economies in transition, in particular to support SMEs, small entrepreneurs, and community-based enterprises;
(x) restructure unsustainable debt in a timely and efficient manner;
(xi) expedite the transfer of environmentally sound technologies in a cost-effective manner;
(xii) build greater capacity in science and technology for sustainable development;
(xiii) increase the flow of foreign direct investment into sustainable development activities including providing infrastructure.

Implementing JPOI is intended to promote the integration of the three components of sustainable development—economic development, social development, and environmental protection—as interdependent and mutually reinforcing pillars. Poverty eradication, changing unsustainable patterns of production and consumption, and protecting and managing the natural resource foundation of economic and social development are seen as the main objectives of sustainable development. Of these, poverty eradication has become the overarching institutional objective for most multilateral agencies, including ADB, as well as the highest priority for most developing countries.

Hard and soft international laws have been important but insufficient as the environment has continued to deteriorate despite the proliferation of treaties, agreements, and plans of action. There is little question, however, that these treaties are helping to shape the policy context within which corporations operate. As noted, criticisms have been raised that, "…the response that the international community has mounted has been flawed: the root causes of deterioration have not been addressed seriously, weak multilateral institutions have been created, consensus-based negotiating procedures have ensured mostly toothless treaties, and the economic and political context in which treaties must be prepared and implemented has been largely ignored."[125]

Furthermore, global agreements are often mirrored in regional and subregional programs and plans for implementation. Leading up to WSSD, a high-level meeting held in Phnom Penh in November 2001, for example, adopted the Regional Platform on Sustainable Development in Asia and the Pacific which identified seven initiatives:[126]
(i) capacity-building for sustainable development; (ii) poverty reduction; (iii) cleaner production and sustainable energy; (iv) land management and biodiversity conservation; (v) protection and management of and access to freshwater resources; (vi) oceans, coastal, and marine resources and sustainable development of small island developing states; and (vii) action on atmosphere and climate change.

At about the same time, UNEP produced its second Asia-Pacific Environment Outlook and UNESCAP released its State of the Environment in Asia and the Pacific 2000, both prepared in conjunction with ADB.[127] The 2000 Ministerial Conference on Environment and Development (MCED) in Asia and the Pacific was held in Kitakyushu, Japan and resulted in the Regional Action Program for Environmentally Sound and Sustainable Development: 2001–2004 as well as the Kitakyushu Initiative for a Clean Environment. At the fifth MCED held in March 2005 in Seoul, Republic of Korea, the Seoul Initiative—a program of action covering the 5-year period until the next MCED to support "environmentally sustainable economic growth"—and a revised regional implementation plan were approved.

JPOI specifically referred to the Phnom Penh Regional Platform on Sustainable Development, which recognized that the region contains over half of the world's population and the largest number of the world's people living in poverty. Hence, poverty reduction in this region was recognized as critical to achieving sustainable development at the global level.

Implementation at the regional and subregional levels was made a key requirement of JPOI.[128] Acting on this "mandate," UNESCAP produced the Regional Follow-up to the World Summit on Sustainable Development in Asia and the Pacific.[129] The subregional initiatives in this action plan were based on planned or ongoing activities with existing or likely financial and technical support from major partners, so there is an element of fitting existing programs into JPOI objectives rather than starting new ones. UNESCAP was concerned that no unfunded programs should be proposed. The subregional initiatives suggested in the publication are as follows:

- **Central Asia**: (i) Regional Environmental Action Plan for Central Asia and (ii) integrated water resources management;
- **Northeast Asia**: (i) cleaner production,

(ii) transboundary air pollution including abatement of dust storms, and (iii) desertification and land degradation;

- **South Asia**: (i) poverty reduction and food security, (ii) natural disaster mitigation, and (iii) public awareness and participation;
- **Southeast Asia**: (i) sustainable development of urban areas, (ii) globalization and its impacts, and (iii) Strategic Environment Framework for Greater Mekong Subregion;
- **South Pacific**: (i) Pacific Regional Environment Strategy and (ii) protection and management of coastal and marine ecosystems.

Regionally, the follow-up plan to implement the commitments made at WSSD adds little to previous global objectives other than referring to specific ongoing or already planned subregional activities and programs, most of which are to be carried out by governments in partnership with international organizations. Of the five subregional programs proposed, those of greatest import for the corporate sector are probably cleaner production in Northeast Asia and globalization and its impacts in Southeast Asia, but to date neither has been translated into substantive national programs. Hence, from the regional follow-up to JPOI, there appear to be few instances of regional agreements, plans, or programs generating specific standards or other constraints on industry.

Yet, there may be some subregional agreements worth the attention of corporate managers. The ASEAN Agreement on Transboundary Haze Pollution, for example, was formulated after the disastrous agricultural and forest fires in Indonesia in 1997 and 1998. They burnt some 9.7 million hectares, emitted 700 million tons of carbon dioxide, and caused damages estimated at $9 billion–$10 billion. This innovative, legally binding environmental agreement aims to prevent and monitor transboundary haze pollution as a result of land or forest fires. The agreement states that, "…the Parties shall take legislative, administrative, and/or other measures to implement their obligations under the agreement." Ratified by Brunei Darussalam, Malaysia, Myanmar, Singapore, Thailand, and Viet Nam, the agreement took effect in November 2003. Unfortunately, the linchpin country, Indonesia, has yet to ratify it. With the exception of Government Regulation No. 4 of 2001 (Control of Environmental Degradation and/or Pollution in Relation to Land and/or Forest Fires), Indonesia has not yet put in place adequate legislation, administrative arrangements, or other measures to address the root causes of the problem: illegal use of fire to clear land for private plantations even in very dry years.[130] Even in the weak El Niño year of 2004, the fires returned with thick haze forming more than 1,000 hotspots although with less damage than in the very dry years of 1997 and1998. The situation was even worse in 2005. The 11th Ministerial Meeting on Haze in November 2004 merely agreed on the need to remain vigilant and to take necessary preventive and mitigating measures. This illustration shows that subregional agreements—like global ones—may ultimately lead to legislation, regulations, or standards, but it is usually a slow process.

Another innovation emerging from the 2002 WSSD was the concept of "partnerships." In line with a growing interest in simultaneously promoting economic development, social progress, and environmental protection, the conference called for the establishment of voluntary partnerships between any combination of governments, intergovernmental organizations, corporations, and other organizations. These partnerships are designed to solve particular sustainable development problems. As of January 2004, 266 partnerships were formally registered with the UN Commission on Sustainable Development, with approximately 60 of these being in the Asia and Pacific region. They cover a variety of themes the majority of which focus on improved water management, sustainable production and consumption, biodiversity, and agriculture.[131]

Some of the global-local partnerships of interest to the private sector in Asia and the Pacific include the following:[132]

(i) awareness-raising and training on sustainable consumption and production;
(ii) Be the change! Youth-led action for sustainable development;
(iii) Capacity 2015: Building capacity to benefit from globalization and to realize the MDGs while achieving sustainable development;
(iv) capacity-building taskforce on trade, environment and development, Phase II;
(v) capacity building in small island developing states to manage vulnerability and develop resilience, particularly to disasters;
(vi) capacity development for improved agriculture and the management of natural resources in the drylands of the world;
(vii) EcoSanRes, an international network for communications, research, and capacity development in ecological sanitation;
(viii) engaging the advertising industry to help communicate sustainability around the world;
(ix) environmental law capacity building program for sustainable development;
(x) environmental management capacity building for local government;
(xi) global technology transfer and knowledge management partnership;
(xii) linked university consortia for environment and development—industry and urban areas;
(xiii) local capacity building and training on sustainable urbanization: a public-private partnership;
(xiv) business alliance for solar water heaters;
(xv) the cement sustainability initiative;
(xvi) cleaner fuels and vehicles partnership;
(xvii) collaborative labeling and appliance standards program;
(xviii) certification for sustainable tourism;
(xix) the industrial energy efficiency initiative;
(xx) mandatory disclosure of automotive emissions.

Conceivably, some of these 20 partnerships could result in voluntary agreements between governments, civil society, and the private sector at the national and/or subregional levels, although most are still in the start-up phase. While it is relatively easy to enter into these arrangements, it is much harder to make them work effectively, to measure their real impact, and to sustain them in the longer term.

The substantial shift toward transnational environmental targets and standards in recent years has mainly been due to the character of modern environmental problems that elude effective national response. Problems that cross national boundaries and problems of the global commons require multilateral responses. Resolution of most global concerns, however, can only take place in practice at the level of the nation-state; hence, the slogan "think globally, act locally." Accordingly, there is extraordinary worldwide growth in demand for improved environmental performance from corporations that is being built into national laws and standards. Many of the partnerships listed above will attempt to implement the "think globally, act locally" principle. This process will continue, and could possibly accelerate in Asia and the Pacific as the region struggles to catch up with the environmental quality of the developed world.

QUASI-STANDARDS

So far, this chapter has discussed environmental performance standards that are mandated either by "hard law" and backed by the threat of legal penalties or by "soft law" supported by government policy and the commitment of international development partners. Increasingly, however, new standards are being developed by the private sector itself working either independently or in collaboration with governments and industry associations. While these standards do not have the force of law or of government policy, in many instances they are becoming de facto or quasi-standards because the market demands adherence to them. This section deals with two types of quasi-standards that are rapidly becoming important drivers of corporate environmental performance. These are VAs and harmonized environmental management systems, or more specifically, the ISO 14000 series.

Voluntary Agreements

Even where VAs are initiated by governments, their very nature implies that corporations can choose to accept or reject them. These initiatives may include agreements between regulatory agencies and corporations (which can be either non-binding or negotiated legal contracts and are often called "public-private partnerships") or among firms in an industrial sector, or they can be unilateral commitments by firms to meet a certain standard or carry out a particular practice. Sometimes they also involve consumers, for example, in for recycling or safe disposal programs.

The last decade or so has seen a dramatic increase in the use of VAs, especially in developed countries.[133] For example, the United States Environmental Protection Agency (USEPA) has calculated that there were 13,000 corporations involved in VAs in the US in 2000.[134] The reasons for this increase have been studied in some depth and appear to relate to both external and internal factors. External drivers include (i) the coercive influences of regulatory forces, market pressures,[135] and societal expectations; (ii) modeling on other organizations; and (iii) political cultures of jurisdictions. Internal drivers include (i) organizational culture, (ii) organizational learning styles, and (iii) the influence of individuals.[136] Overlaying all of this has been a strong trend over the last decade toward greater decentralization of environmental governance and toward subnational units and an increased engagement of intergovernmental organizations and NGOs.[137]

It is unlikely that any single dimensional typology can capture all the relevant differences among VAs because there will always be substantial variation within categories. Based on three recent reports,[138] however, three general types of VAs can be identified:

(i) private agreements between firms or between firms and stakeholders;
(ii) public voluntary programs developed by government agencies in which individual firms are invited to participate;
(iii) environmental agreements negotiated between industry and public authorities.

Private agreements do actively involve the public sector although regulators would almost always support them. There are two forms worth noting. The first is a situation where corporations "sign up" to a code of conduct. These codes can be established either by broad coalitions of interests or by industry associations attempting to self-regulate an entire sector. Examples of the former include the CERES principles that brought together a number of US environmental groups and socially responsible investors after the Exxon Valdez oil spill in Alaska. They commit members to protecting various environmental "components," and emphasize monitoring and reporting on progress. To date, more than 80 organizations and 70 firms have signed onto the CERES principles.

Other examples of codes established by coalitions of common interest include (i) the International Chamber of Commerce's Business Charter for Sustainable Development which has 2,000 corporate signatories; (ii) WBCSD's global network of 45 national business councils and partner organizations located in 40 countries involving some 1,000 business leaders globally united by a shared commitment to sustainable development via the three pillars of economic growth, ecological balance, and social progress; and (iii) the Sustainable Development Charter of the International Council for Metals and the Environment. This "broad coalition" approach to codes of conduct has been described as establishing broad guiding principles and statements of intent across subscribing organizations. They are often considered to be a first step providing common policy direction and a broad framework of action.[139]

A second type of code of conduct is where an industry association establishes an environmental charter that professes to cover an entire sector. There are now a vast number of industry association-generated environmental codes in existence around the world—too numerous to list here. These codes can establish the following:

(i) process-based management systems such as EMS;
(ii) performance-based management systems that establish minimum levels that must be met by all subscribing corporations like the demands placed on members of the Forest Stewardship Council and the Marine Stewardship Council;
(iii) hybrid process-based systems with performance elements.[140]

Most industry association codes apply in specific jurisdictions and cover sectors that are either high profile (e.g., mining), or pollution intensive (e.g., pulp and paper, textiles, petrochemicals).[141] While codes of conduct tend to be developed by national industry associations, they often have application outside of a nation-state. Two significant examples are the Australian Minerals Industry Code for Environmental Management,[142] and the international chemical industry's Responsible Care program.[143] The Australian mining code has 39 signatories representing over 300 sites and applies wherever a corporation operates around the world. As with most industry association codes, it includes commitments to improved environmental performance, to improved relations with customers and communities, and to greater transparency. As such, the Australian mining code requires signatories to commit to the following seven "elements and activities":

(i) accepting environmental responsibility for all actions;
(ii) strengthening relationships with the community;
(iii) integrating environmental management into decision making;
(iv) minimizing the environmental impact of activities;
(v) encouraging responsible production and use of resources;
(vi) continually improving environmental performance;
(vii) communicating environmental performance.

In implementing the code, signatories are required to publicly report their environmental performances and to assess their progress against code principles every year as well as to submit to an external, independent audit every 3 years.

The Responsible Care initiative was developed after the Bhopal disaster in India and now operates in 47 countries.[144] It is based on a set of guiding principles and six codes of practice with 152 individual elements covering (i) community awareness and emergency response, (ii) research and development, (iii) manufacturing, (iv) transportation, (v) distribution, and (vi) hazardous waste management. The codes set broad environmental objectives but do not specify performance levels. Firms set their own performance levels according to their circumstances, although a recent development by the US Chemical Manufacturer's Association has its member firms committing to one or two "beyond compliance" targets and mandatory third-

party verification.[145] The Responsible Care Management System has been merged with ISO 14001 to become RC14001, a single, cost-effective certification process.

The second kind of private agreement takes place between firms and stakeholders. There are numerous examples where corporations have negotiated with communities to reduce their pollution impact. Most of these are true private agreements and so are not publicly known. Over the last decade, a large number of agreements has been reached between corporations and NGOs representing shareholder groups that seek to transparently develop mutually beneficial solutions to environmental and development problems. An example of this kind of initiative is the Asia Foundation-sponsored NGO-Business Environmental Partnership Program. Through this program, the Foundation has made over 80 grants to NGOs in 9 countries, and more than 500 groups have attended workshops on cleaner production and partnerships in industrial sectors, including agricultural-processing, automotive, chemical, hotel, hospital, metal-finishing, tanning, and textile industries.[146]

While there are many of these types of new business arrangements in Asia and the Pacific, they do not tend to lead to general environmental standards or even to quasi-standards. Nevertheless, they do raise the level of awareness within participating corporations and may set the stage for improved compliance.

In public voluntary programs, the regulatory agency unilaterally determines the rewards and obligations from participation as well as the eligibility criteria. It designs the program, and then seeks participation from companies given the terms it specifies. These are effectively non-mandatory rules developed by a government body (though they often can be modified through a process of public-private dialogue).

While there are not that many of these programs in existence, some have a large number of participants and, as a consequence, they set effective standards in certain sectors. Researchers have suggested that there are approximately 20 such agreements in Europe and around 40 in the US.[147] There appear to be few examples of such approaches in Asia and the Pacific as the region has tended to rely more heavily on command-and-control systems perhaps due to a concern that not many corporations would participate. The best-known public voluntary programs include the following:

(i) 33/50 within which the USEPA encouraged manufacturers to voluntarily reduce emissions of 17 target chemicals by 33% by 1992 and 50% by 1995 with 1988 as the baseline;[148]
(ii) Canada's Accelerated Reduction/ Elimination of Toxics program where industry was challenged to reduce discharges of 30 specified chemicals by 90% and 87 others by 50% by 2000;
(iii) The USEPA's Green Lights program which encouraged the installation of energy-efficient lighting technologies in commercial and industrial buildings.[149]

More recent public voluntary programs also incorporate a "challenge" whereby governments are hoping to encourage corporations to identify improvements in energy use, chemical use, and waste minimization. Some examples include the French Glass Packaging Agreement[150] and the Australian Greenhouse Challenge.[151] The Australian Department of Environment and Heritage has entered into voluntary, 3-year eco-efficiency agreements with 25 industry associations covering the energy industry, paper industry, commerce, aquaculture and fisheries, automotive industry, wine and brandy, and housing industry.

These programs invariably involve some kind of target setting the firms. In addition, the programs will often require the implementation of particular management systems. Governments clearly need to offer inducements for corporations to join such programs which might include (i) technological or financial assistance, (ii) public relations benefits, (iii) avoidance of more direct regulation or reductions in administrative binders under existing regulations, and (iv) greater flexibility in reaching targets.

Negotiated environmental agreements have similarities in form with public VAs but differ in that they often contain specific performance targets and are more or less legally binding. They are also negotiated between government and industry to the point where the initiatives are "co-managed" with a sharing of responsibilities for their implementation and monitoring. In some cases, third parties can also have an advisory role.[152] In a legal sense, some of these agreements can be thought of as contracts and thus would not be truly "voluntary."

Developing negotiated agreements sometimes takes place initially with an industry association or other representative of an industrial sector, often at the national level. Examples of these initiatives include the Brazilian Tripartite Agreement on Benzene (1995), the European Cement Association Voluntary Initiative to Reduce Carbon Dioxide Emissions, the Australian Packaging Covenant,[153] the Dutch environmental covenant approach[154] and the Canadian Environmental Performance Agreements.[155] Once general sector-wide core design criteria are agreed upon, then specific performance agreements can be negotiated with individual corporations although this extension toward traditional regulation only happens in some jurisdictions.

Research suggests that negotiated agreements represent the most popular form of voluntary initiative in Europe where they have been developed in the areas of waste management, climate change, ozone depletion, and water pollution. For example, over 100 negotiated agreements have been signed in the Netherlands since it started using this approach in 1989. Negotiated agreements tend to be entered into by industry and governments with a background threat of stricter regulation if the agreement does not result in environmental improvements. An example of this situation occurred in Germany in 1995 when the Federated Association of German Industry agreed to reduce carbon dioxide emissions up to 20% by 2005 in exchange for a federal government agreement not to introduce a waste heat ordinance.[156]

An Asian example of a form of negotiated environmental agreement that has operated for more than 30 years is the Japanese environment and pollution control agreement (EPCA). More than 1,000 EPCAs are negotiated in Japan every year, and there are approximately 30,000 currently in place.[157] EPCAs are concluded between local authorities, firms, and local residents' groups to set and meet environmental goals in particular local contexts. The conditions of EPCAs vary, from vague declaratory statements, through to setting specific targets that are backed up with penalty clauses.

An example of the extent of variation can be seen in a comparison of EPCAs from Kitakyushu and Yokohama cities. The former agreement includes targets such as those to, "…achieve the national ambient air quality standard for sulfur dioxide," where the latter requires that, "…concentrations of sulfur dioxide be below 500 parts per million."[158] Another significant difference between the two agreements is that Yokohama's is with single companies and Kitakyushu's is a collective agreement concluded between the local authority and more than 100 emission sources.

There are several examples of negotiated agreements already in place in developing countries. In the mid-to-late 1990s, the Colombian government signed 11 negotiated agreements with different industrial sectors (small-scale gold mining, coal, sugar cane, pig breeding, flower growing, oil producing, electricity, palm oil, pesticides, and brick manufacturing) all of which sit beneath the national Framework Agreement on Cleaner Production that was the personal initiative of the then environment minister. In Mexico, 10 sector agreements involving more than 600 companies have been negotiated under an amendment to the General Act on Ecological Equilibrium and Environmental Protection.[159]

There are very few known examples of negotiated environmental agreements in the developing countries of Asia and the Pacific although tentative steps have been taken in India and Thailand.[160] It is highly likely that this situation will change soon, possibly quite rapidly.

Voluntary agreements as "standards:" VAs can take many forms, are rapidly expanding in application, and will soon make an impact on the operations of corporations in Asia and the Pacific. What is not always clear is that just like traditional command-and-control policies, these new mechanisms are starting to define compliance standards that corporations must meet. Sometimes these agreements are reinforcing compliance standards that are already in place as a result of traditional regulation. This is the case with some negotiated environmental agreements where performance is required by contract. A good example is the Japanese EPCA approach described earlier. More often, however, VAs are resulting in de facto or "private" standards.

De facto standards result when any of the three types of voluntary measures that involve industry associations or sector aggregations of firms produce targets that did not already exist in traditional regulations. In developing countries with weak regulatory structures, it is likely that these situations will be common. Governments may prefer to shift the onus onto corporations rather than to wait for a slow build up of capacity in the national environment agency.

"Private" standards are developed when corporations in a similar industrial sector band together to establish tougher environmental performance conditions (by way of voluntary measures) than previously existed. Companies that participate in such programs gain competitive advantage over nonparticipants by creating a cleaner image and reducing risks and compliance costs. The basic idea is that tightening regulations will hit nonparticipating competitors harder than participating ones who have gained a first-mover advantage. With this strategy, environmental costs can increase but at a rate that is lower than for competitors. While this kind of scenario may not result in a legally mandated environmental performance standard, there is no doubt that it can be just as influential in encouraging firms to achieve compliance. Corporations that are not part of whatever voluntary measure has resulted in a private standard are still embedded in networks of suppliers, customers, investors, competitors, and communities. These networks influence a firm's decisions on environmental protection and may substantially increase pressures to comply with private standards.

Voluntary agreements and environmental improvement: Generally, VAs have benefited corporations through the incentives governments offer for participation. Benefits include (i) avoiding direct regulation and its associated costs, (ii) greater flexibility in reaching targets, (iii) risk management (including protecting themselves from potential litigation), and (iv) assuring or enhancing their reputations.[161]

A question remains as to whether or not VAs have led to overall environmental improvement. Numerous attempts have been made recently to evaluate their effectiveness and efficiency.[162] Most researchers agree that evaluating the effectiveness of VAs is especially difficult due to problems of data availability, credibility, and self-selection. This has led some commentators to suggest that there has been a tendency to overstate their benefits.[163]

The most influential evaluations claim that the environmental targets of most VAs seem to have been met but that there are only a few cases in which such approaches have been found to contribute to environmental improvements significantly different from what would have happened without the VA.[164] There is also a consensus on why VAs appear to have had only a modest impact on environmental improvement. The most obvious reasons appear to be "free-riding," "regulatory capture," and non-enforceable commitments.[165]

Despite these somewhat negative assessments, there is also significant agreement that VAs can result in "soft benefits." Voluntary agreements can often have indirect effects on organizational culture and practices as well as more direct effects on targeted environmental impacts. These indirect effects include (i) diffusion of information on pollutant abatement techniques, (ii) technical assistance, (iii) best-practice guidelines, (iv) evaluation tools, (v) training, and (vi) enhanced cooperation and trust.[166] While these benefits are difficult to measure, especially in the early stages of VAs, some commentators have suggested that these changes in firms may be even more important than short-term reductions in environmental impact.[167] There is an argument to suggest that these soft benefits may be of particular value in Asia and the Pacific where improved corporate governance is urgently needed.

Significance of voluntary agreements for corporations in Asia and the Pacific: VAs are beginning to have an impact on the approach that corporations in Asia and the Pacific take toward environmental management; this influence will continue to grow. Pressures on corporations will come from both the international and national levels. At the international level, Chapter 2 has shown that there is significant evidence of a policy shift toward greater shared responsibility between public authorities and the business community. As a consequence, VAs that have international "reach"—especially codes of practice—are already operating in Asia and the Pacific, particularly through supply chains, and are pushing firms toward compliance.

These international pressures, combined with examples from developing countries in Latin America, will soon encourage the development of national VAs in Asia and the Pacific. There is a strong argument to suggest that where relevant environmental standards do not apply (or are ill defined), and where there are limited budgetary and administrative resources, then VAs can help to specify what standards should be adopted. This argument is supported by the "soft benefits" view mentioned earlier. Some commentators have suggested that private codes and some notion of private sector environmental responsibility could potentially serve as valuable adjuncts to intergovernmental programs and public-sector initiatives when transferring environmental technologies and management practices to developing nations.[168]

On the other hand, there is a counterview that VAs only work in jurisdictions where there is already strong regulation that can act as a "credible threat." In this argument, large firms—especially MNCs—will use the VA approach to exploit countries where standards and enforcement are weak. There is, however, no solid evidence that this extension of the "pollution haven" concern is valid.[169] Other commentators have suggested that the role of regulation as a "backup threat" is overplayed, and that developing country corporations could be motivated to participate in VAs for a range of other reasons including (i) community/NGO pressure, (ii) protection of reputation, (iii) enhanced market opportunities, (iv) requirements of financiers, and (v) pressure from industry peers.[170] In some developed-country jurisdictions, the role of the judiciary and of interested third parties may make negotiated agreements less easy to enforce. Given outstanding issues of poor governance in many developing countries, the institutional setting may determine how effective such VAs can be in Asia and the Pacific.

While there is no current resolution to this debate, there is a clear understanding that VAs do not necessarily work in all circumstances. There is now a growing understanding of the institutional and procedural conditions that might have to be present for VAs to be successful. Future developments needed for VAs to become effective in Asia and the Pacific are discussed in Chapter 7.

ISO 14000 Series

The VAs outlined in the previous section tend to be made in a collaborative rather than unilateral fashion; the extent of their development around the world is the main reason why they are resulting in quasi-standards. One type of unilateral environmental commitment, however, has resulted in the establishment of a new kind

of performance standard. When EMSs are sufficiently harmonized across companies in a sector, they may be regarded as quasi-standards though not all EMSs fall into this characterization, however. Other forms of EMS are discussed in Chapter 4.

Since it was launched in 1996, "ISO 14001" has become the most commonly used EMS meta-standard. The Swiss-based International Standards Organization is a worldwide NGO made up of national standards bodies from 111 countries. ISO standards are developed through "expert" consensus-building processes where members contribute to, and ratify, the outcomes. On the surface, it would appear that developing countries have played a significant role in the design of ISO 14001. In the technical committee that drafted the EMS standard, for example, 28 of the 51 participants or observers were from developing countries.[171]

The adoption of the ISO 14001 standard by corporations has increased dramatically since its establishment. By April 2005, 88,800 certificates had been issued in more than 110 countries. This is an increase of more than 35% over 2002.[172] While ISO certification is clearly attractive to many firms, uptake has been uneven across countries. The top 10 countries for ISO certificates are Japan (18,104) which leads by a wide margin over the PRC (8,865), Spain (6,523), UK (6,223), Italy (5,304), US (4,671), Germany (4,440), Sweden (3,716), Republic of Korea (2,610), and France (2,607). Other Asian countries have smaller rates of participation. After Japan, the PRC and the Republic of Korea, the more significant Asian participants are India (1,500); Taipei,China (1,463); Thailand (974); Singapore (573); Malaysia (566); Indonesia (369); Hong Kong, China (355); and the Philippines (312). Asian corporations make up approximately 40% of the world total. Possibly the most significant statistic from the region is the substantial increase in certifications from PRC corporations—up by more than 200% from 2002 to 2005, from 2,802 to 8,865.

ISO 14001 as an environmental "standard:" The ISO 14001 standard is different from the categories of standards discussed earlier. Because it was designed and adopted by a body whose members include national standard-setting organizations, it is not legally binding on any of the parties nor on the corporations that sign up for it. It is also different because its focus is on technical standardization and performance specifications, not on setting performance targets. This is not surprising given that the original reason for the existence of ISO was to ensure the uniformity and harmonization of international product performance requirements.

Despite its essentially voluntary nature, ISO 14001 has expanded its influence to the point where it may now be considered to be an "involuntary" standard with similar if not more power than mandatory regulations. The first reason for this development is the new link that the standard has with the WTO. The Uruguay Round of GATT strengthened the GATT Standards Code that urges governments to use international standards to make the free circulation of goods across national borders easier. The ISO has formal legal authority to establish its international standards under the WTO's Technical Barriers to Trade Agreement. As a result, national governments must take ISO standards into account when setting their own national, subnational, or local standards.[173] In a sense, this means that ISO standards such as 14001 have greater status due to their ties to WTO sanctions than do existing international environmental standards established through other multilateral rule-making institutions

The other main reason why ISO 14001 can be thought of as an "involuntary standard" is because it has become a de facto condition of the marketplace. ISO's earlier standard for quality assurance (ISO 9000) rapidly took on this role and in many jurisdictions became a prerequisite for government procurement contracts. There is a growing understanding that the same thing will happen for the environmental management standard. Some commentators claim that this will make ISO 14001 a "ticket of market access," and that it will drive corporations in developing countries to sign on for reactive reasons rather than because of a drive to improve environmental management.[174] Progress is also being made in developing an equivalent social standard.

For both of these reasons, ISO 14001 is clearly a quasi-standard that cannot be ignored by corporations in Asia and the Pacific, especially if they are involved with exporting and dealing with MNCs.

FINAL WORDS

Corporations in the region have often struggled to comply with national environmental performance standards due to a range of factors such as (i) the lack of regulatory resources to enforce standards; (ii) uncertain laws with few penalties for noncompliance; (iii) corruption; (iv) inadequate laboratory facilities and an inability to collect evidence that is reliable enough to secure prosecution; and (v) a lack of information about laws and clean technologies.

A vast array of regulations and standards, both traditional and "new" are beginning to impinge on corporations' freedom to operate. These are emanating from (i) subnational and sector goals and targets, (ii) national environmental laws and standards, (iii) commitments that governments make to global and regional agreements; and (iv) industry-led "new regulation" or quasi-standards. Corporations in Asia and the Pacific can no longer ignore these pressures if they want to compete.

As firms move closer to compliance and encounter the "new" forms of regulation, they will be challenged to consider the possibility of going beyond compliance. For firms ready for this step, this approach brings with it many types of new business opportunities and new challenges to their corporate cultures. In the next chapter, some of the most significant tools for enhanced environmental performance are discussed, tools will lead many firms to recognize and capitalize on the new business opportunities discussed in Chapter 5.

CHAPTER 4

Sustainability Toolkit for Compliant Corporations

Given the tremendous pressures that companies in the region are facing to comply with rapidly developing formal and informal environmental performance standards, what guidance can be provided to enable them to take a proactive approach to improving their environmental management practices?

Fortunately, in recent years various diagnostic and reporting approaches have been experimented with that allow firms to make unilateral performance improvements including five practical tools: (i) EMS, (ii) corporate environmental auditing and reporting, (iii) benchmarking, (iv) LCA, and (v) environmental management accounting.

ENVIRONMENTAL MANAGEMENT SYSTEM

The mechanics of EMS: EMS are internal and are aimed at improving the environmental performance of an organization. Developing EMS generally involves corporations answering the following six questions:

(i) What are the broad outcomes that are required from environmental management?
(ii) What are the environmental impacts associated with the organization's activities, products, and services that will affect these outcomes?
(iii) What is the organization's policy in relation to environmental issues?
(iv) What are the organization's objectives and targets for environmental management?
(v) What systems and procedures need to be implemented to achieve the policy, objectives, and targets?
(vi) How is the performance of the system to be evaluated?[175]

A corporation can answer these questions without any external help, and until the early 1990s, this is what proactive firms would have done if they had wanted to improve their overall environmental performance. At about that time, however, a number of "meta-standards" were developed to provide general specifications of what should be included in a management system.[176] The best known include those of ISO, the British Standards Institution (BS 7750), and the European Community (Eco-Management and Audit Scheme). While there are some substantial differences in what they attempt to achieve, all three standards are broadly similar in that they provide a harmonized framework to ensure that a corporation meets its legal obligations and that it commits itself to a process of continual environmental improvement.[177] While there are a number of models for EMS in existence,[178] the most recognized is the ISO 14001 standard discussed in the previous chapter. It specifies the requirements for EMS against which an organization may be certified by a third party. It is important to note that ISO itself is not involved in certification beyond setting the standard. The specification includes:

(i) the development of an environmental policy;
(ii) identification of "environmental aspects" or impacts;

(iii) establishment of relevant legal and regulatory requirements;
(iv) development of environmental objectives and targets;
(v) establishment and maintenance of an environmental program to achieve its objectives and targets;
(vi) implementation of EMS, including training, documentation, and operational control;
(vii) monitoring and measuring operational activities, including record-keeping;
(viii) EMS audit procedures;
(ix) managerial review of EMS to determine continuing suitability, adequacy, and effectiveness.[179]

While this system appears to bring some rigor into the way in which a corporation approaches environmental management, several commentators have pointed out that implementing EMS using the ISO standard does not guarantee that environmental performance will be improved. ISO 14001 is a continuous improvement process, not a performance standard. Just as an accounting system does not automatically ensure that a corporation will be profitable, so ISO certification does not guarantee that a firm's environmental problems will be solved. In fact, ISO 14001 does not require firms to demonstrate actual improvements in environmental performance. It only requires them to commit to doing so and to follow through on these commitments, and it views active EMS as evidence of such commitment. Some critics claim that it is theoretically possible for a corporation to be out of compliance but still maintain its certificate because it remains "committed to compliance."[180]

Adoption rates: While it is still early days for ISO 14001, some initial research has investigated a marked divergence recorded in adoption rates across countries. Preliminary work in the PRC has shown that the four strongest factors determining whether a corporation adopts ISO 14001 are (i) multinational ownership, (ii) a high proportion of sales to multinational customers within the PRC, (iii) a large proportion of output exported to developed countries, and (iv) a high proportion of output exported to developed countries that are active adopters of ISO 14001.[181] Clearly, it is the internationally connected and export-oriented firms that are adopting this approach.

This research is supported and extended by more recent analysis of data from 59 countries that suggest that ISO 14001 adoption rates are likely to be higher in countries (i) whose trading partners have adopted the same meta-standard, (ii) embedded in international networks of NGOs, (iii) whose governments flexibly enforce stringent environmental regulations with a less adversarial and litigious stance toward firms, and (iv) where consumers want mechanisms for identifying environmentally progressive firms.[182] These findings go a long way toward explaining why the US has a relatively small uptake of ISO 14001 but probably a larger variety of EMS and why corporations in the PRC have taken to this harmonized form with more enthusiasm in the recent past. It also supports the arguments outlined in Chapter 2 that pointed to the importance of global supply chain pressures.

EMS and environmental performance: ISO 14001 was formally established in 1988, so evaluations of its impact on actual environmental performance are rare and can only be considered as preliminary. A large survey of 1,510 US firms published in 2000 found that overall, the systems were not seen in a positive light. Managers surveyed saw them as having a negative impact on the major strategic dimensions of performance (lead time, costs, and quality). There was, however, a strong positive relationship between the stage of ISO 14001 certification and the effectiveness of the EMS. In other words, the closer the firm was to attaining ISO certification, the greater the positive impact that EMS had on the overall performance of the firm. Of the firms in the sample that had been certified, the majority said that their EMS had reduced waste in the production and had enhanced the reputation of the company.[183] A smaller survey of ISO 14001-certified firms in Australia found that 89% of their managers could point to improved environmental performance as a direct result of EMS. Examples varied depending on industrial sector but commonly focused on pollution control, improvements in production efficiency, and increasingly efficient use of energy and water. Respondents also pointed to "ancillary" benefits such as (i) assisting in the assessment of risk, (ii) cost savings in relation to resource inputs and waste outputs, (iii) integration with health and safety provisions where efficiencies could be obtained by coordinating ISO processes, and (iv) improved compliance with regulatory conditions.[184]

Finally, World Bank research in Mexico has shed light on the relationship between EMS and compliance rates that might be more relevant to the developing economies of Asia and the Pacific. A survey of 236 factories in heavily polluting industrial sectors showed that there is a direct relationship between adopting ISO 14001 and compliance. As with the US survey mentioned earlier, the Mexican work showed that the closer a firm is to certification, the more environmental benefit it obtains. For example, 86% of plants with high EMS adoption scores were complying with environmental regulations while only 24% of plants with low scores were.[185]

Significance of EMS to corporations in Asia and the Pacific: There is considerable pressure on corporations in Asia and the Pacific that export and/or work with MNCs to adopt acceptable EMS. ISO 14001 is rapidly becoming the de facto standard demanded by the market, and this is further encouraged by the link between ISO and WTO. These pressures will continue to build and, in the near future, corporations that cannot show evidence of acceptable EMS in place will find it difficult to do business outside of their national boundaries.

As noted, adoption of EMS under ISO 14001 rules does not directly specify a level of environmental performance. A cynical view could have it that corporations have an incentive to appear to be adhering to strict self-regulation to which they may in fact be only superficially committed. Unless there are solid gains from the improved inputs and other measures associated with establishing EMS, it is quite possible for certification to become an end in itself with little genuine commitment to environmental improvement.

In many developing countries where the traditional tools of command-and-control regulation have not worked well, mandatory adoption of EMS could offer a real opportunity for governments to extend their enforcement capabilities. Given the risks that the systems might be superficial, however, it is important for both corporations and governments to think carefully about how to make them truly effective and not merely symbolic. For corporations, it appears that for EMS to actually reduce environmental impact, there needs to be a combination of external pressure (from regulators or other stakeholders) and internal pressure from corporate culture or strong leadership. The structure of the systems clearly allows for firms to identify shortcomings and to make genuine improvements. Case studies and surveys have shown this to be the case.[186] For governments, EMS will need to be integrated into public law and policy. The end result will likely be a system of "co-regulation" between the private and public sectors. Generally, regulators using ISO 14001 as a basis for co-regulation will need to investigate ways of extending the standard to allow for forced compliance, evidence of measurable improvements in environmental performance, and public scrutiny of third-party verifications. Open-ended commitment to undertake environmental improvements should not be accepted. This approach is discussed in more detail in Chapter 7.

CORPORATE ENVIRONMENTAL AUDITING AND REPORTING

Auditing: How do managers know when their firms are continuously improving their environmental performances? First, they need internal EMS so that they can monitor and measure performance. Then they need an independent but internal auditing system that warns top management of potential risks and failures of line managers to meet performance targets. One of the earliest uses of an environmental auditing system was in the 1980s in response to a spill of a toxic chemical that polluted the James River in Virginia in the US. Commercial fishing and shellfish harvesting was suspended for 6 months, and the company was forced to pay what was then the largest environmental fine ever. The company retained an accounting firm to design an internal auditing system to prevent such incidents from recurring. Since that time, auditing has been adopted in one form or another by virtually every MNC worldwide. Just like financial audits, most firms assign special teams to conduct them and use outside consultants to provide third-party verification that the system is accurate.

Firms have resisted all efforts by national governments to mandate such audits arguing that a legally binding auditing system would result in a lowest common denominator system dominated by lawyers. The internal system enables top managers to get the unvarnished truth from operating divisions without fear of government intervention. Then management can decide how best to manage risk and ensure that the firm complies with all environmental requirements with adequate margins of safety. There is a wide variety of auditing models and a wide variety of third-party verifiers willing to audit a firm's internal environmental auditors. Each company must choose a system that enables management to reduce risk and ensure compliance. There are costs associated with auditing just as in any other form of insurance coverage, but experience has shown that companies with environmental auditing systems reduce risks and are able to reduce the costs of liability coverage in addition to avoiding fines for noncompliance.

Environmental reporting: While audits are useful for providing internal management information, how do managers communicate their environmental performance to stakeholders when they have good news to report? Perhaps the first question to ask is, why bother to communicate at all? It is possible for firms to "fly under the radar" and seek anonymity in the short term, a strategy still used by many firms in the region. Silence, unfortunately, can be perceived as having something to hide or, at least, nothing good to report. External reporting signals that the firm is actively trying to manage its environmental impact. Reporting, assuming it is accurate and not just for public relations, monitors progress, documents successes, and gives the firm credit for its efforts. Its reputation can be enhanced, and its products can be given an environmentally friendly tag. In the best case, firms can increase their market shares or stock prices as environmentally responsible. Nevertheless, even in the best-managed firms there is always the inevitable upset, accident, or spill. Firms that have consistently reported and earned a good environmental reputation are more likely to be given the benefit of the doubt when such an event occurs.

For many years, firms in OECD countries have been required to submit strict financial reports. In recent years these requirements have been extended to cover environmental liabilities though the small section on environmental management has tended to get lost in the complex documents. As a result, in the last decade, several MNCs began to issue autonomous environment reports. Beginning around 2000, many of these reports were transformed into sustainable development reports covering the economic, environmental, and social performance of the firm. In December 2002, the WBCSD issued a report entitled *Sustainable Development Reporting—Striking the Balance.*[187] The three chief executive officer authors stated in their foreword that, "…companies are under increasing pressure from key stakeholders to be transparent about their values, principles, and performance as regards sustainable development. We are seeing a growing recognition by many WBCSD members that external reports dealing with this subject support a company's position and strengthen its reputation. These reports are part of an effective response to the need for greater accountability and transparency."

WBCSD made environmental reports a requirement of membership and encouraged members to move toward a full sustainable development report. "Members should publicly report on their environment performance within 3 years of becoming a member and aspire to widen their reporting to cover all three elements of sustainable development—economic environmental, and social."[188]

Traditionally, there were three key stakeholder audiences for environmental reports: investors, employees, and customers. Today, there are many more diverse stakeholders including current shareholders and potential investors, employees, customers, suppliers, governments and their agencies, the public (particularly the local community where the business is based), NGOs, lenders, and the entire financial community. Sustainable development reports should meet the general needs of most users but should not strive to be everything to everyone. Experience has shown that it is not the quantity but the quality of information that counts.

One complaint of many within the anti-globalization movement was a lack of accountability and transparency on the part of business, especially the MNCs. Environmental or, preferably, sustainable development reporting is a partial answer to these complaints. Reporting does not allay these suspicions entirely. Critics are quick to label all business environmental reports as "greenwash." However, the reports do begin the process of demystifying business and giving various stakeholders a clearer picture of the values, principles, and performance of firms with regard to the environment. Combined with other outreach activities, environment or sustainability reports send a powerful message to key stakeholders.

In additional to WBCSD guidelines, the Global Reporting Initiative described in Chapter 2 provides an even broader model for environmental reporting with UN sanctions. While the GRI model may be too detailed and too difficult for some firms, an acceptable environmental report should cover most of the topics listed.

BENCHMARKING

Another technical aid in the sustainability toolkit is the concept of environmental benchmarking. In general, benchmarking is a performance measurement tool that can be used in conjunction with improvement initiatives to measure comparative performance and to identify best practices. Unlike most of the other environmental improvement tools discussed in this report, however, there is considerable confusion over how the technique itself can be defined. There are also close links between benchmarking practices and certain aspects of other corporate environmental improvement tools.

Benchmarking is most closely associated with corporate performance assessment; however, the concept is increasingly applied at other levels. For example, various projects associated with improving air quality in Asia are attempting to benchmark urban air quality management in the so-called "mega cities" of the region.[189] For the purposes of this report, however, the concentration is on how

benchmarking ideas are applied by corporations to improve their environmental performances.

Often the term "environmental benchmarking" refers simply to listing and comparing (or ranking) the environmental performance of different organizations. There has been a significant expansion in recent years in the number of third-party ranking schemes that have been developed to allow a comparison of companies' performance according to their pollution emissions or to performance as defined by corporate environmental reports.[190] However, benchmarking can mean much more than quantitative measurement of a firm's performance compared to competitors. It can also serve as an improvement tool that involves analyzing the practices that lead to superior environmental performance.

A well-known definition focuses on the improvement aspect of benchmarking suggesting that, "Environmental benchmarking is an environmental management tool that can provide a substantial contribution to the improvement of environmental performance by facilitating the identification of the gap between company performance and a given performance. Any process or business activity can be a candidate for environmental benchmarking."[191]

Benchmarking can be further defined and clarified by examining *what* is being compared, and *against whom* comparisons are being made.[192] There are three categories of the *what* question. First, environmental benchmarking can be thought of as relating to performance (or data) benchmarking. Here, the questions focus on, "How well should we be doing it?" and the benchmarks tend to be standards or targets that have been derived by external organizations such as regulatory bodies or industry associations. Another type of benchmarking relates to process. Here the question is, "How do others achieve it?" This type of benchmarking goes beyond the analysis of performance data to attempt to identify the best practices that lie behind the good performances of others. A third what question relates to strategic benchmarking. Here, the focus is on asking, "What should we be doing?" The comparison is against the strategic choices made by other organizations.

Once it is clear what is being benchmarked, the next question is, *"against whom?"* Benchmarking can be entirely internal. In this instance, comparisons would be between departments or units within the same corporation. Benchmarking can also be against competitors that manufacture the same product or deliver the same kind of service. A third type of comparison can be by function where firms are not direct competitors but share functions. For example, iron ore miners and gold miners might want to compare the way each transports its final product even though they sell to completely different markets. The final against whom category is "generic benchmarking" where the comparison is made with the best processes in existence regardless of the type of industry or service.

Categorizations can be combined to provide a guide to where and when benchmarking might best be applied. Table 3 presents this organizing scheme. This detailed conceptualization of benchmarking points clearly to its potential advantages. Beyond improving bottom-line performance (however defined), the tool can be used to find sources of improvement without trying to "reinvent the wheel." This implies that it can lead to efficiency improvements. In terms of organizational learning, there is evidence that benchmarking can help employees become more receptive to new ideas and can also provide an effective early warning system.

As with many of the tools outlined in this report, most environmental benchmarking has originated in developed countries. However, there is a growing body of experience with use of the technique in Asia and the Pacific. Possibly the most widespread regional application is in the tourism industry where benchmarking and certification programs such as Green Globe 21 have corporate members from all over the region.[193] Donor agencies interested in promoting cleaner production activities have also been active in supporting

Table 3: Benchmarking Schemes

	INTERNAL Benchmarking	COMPETITOR Benchmarking	FUNCTIONAL Benchmarking	GENERIC Benchmarking
PERFORMANCE Benchmarking	Important and necessary process, but does not show what performance is really possible.	Gives external reference points. Good comparability of performance indicators.	Useful for certain aspects, but comparability not always given.	Low comparability of pure figures due to differences in processes and products.
PROCESS Benchmarking	Good place to start and learn about benchmarking, but no breakthrough ideas can be expected.	Would be very useful, but has legal and ethical limitations to sharing process information.	Good way for finding new ideas, and less legal limitations than competitor benchmarking.	Best way to find breakthrough ideas and achieving fundamental improvement.
STRATEGIC Benchmarking	Difficult to find clues on better internal strategies.	Competitors are best partners to get ideas about strategies and planning.	Not too useful because of differences in business ideas.	Not too useful because of differences in business ideas.

Source: European Environment Agency. 2001. Quoting Andersen, B. and Pettersen, P. 1996. *The Benchmarking Handbook. Step-by-Step Instructions.* London: Chapman and Hall.

benchmarking research and demonstration projects. For example, the United States Agency for International Development has provided long-term grant assistance through the Clean Technology Initiative to develop benchmarking for private Indian firms active in a range of sectors (especially water, electricity, and hotels).[194] Finally, UNIDO has recently produced computer software program Responsible Entrepreneur to help enterprises quickly benchmark their environmental performances and identify areas of weakness.[195]

LIFE CYCLE ANALYSIS/ ASSESSMENT

Another corporate environmental management tool that has seen extensive recent use in larger firms is LCA, to identify the environmental impacts of a product, process, or activity throughout its entire "life"—from the extraction of raw materials to processing, transport, use, and disposal.

LCA is sometimes referred to as "cradle to grave" assessment, because it demonstrates that the full environmental impact of an activity can be explained only by examining each step in the value chain all the way to disposal.

The benefits of LCA include the following:[196]

- holistic approaches to determining impacts rather than focusing more narrowly on single issues such as energy inputs or recycling;
- scientific methods to collect and analyze data;
- targets for improvement;
- a rational way to evaluate alternatives.

LCA began in the late 1960s and early 1970s as a tool for analyzing energy efficiency in the period of significant oil price rises. When this crisis dissipated, interest in the technique declined, but it then rose again in the late 1980s as a response to a growing interest in the environmental impacts of products.[197] Over the 15 years since its initiation as an environmental management tool, LCA has been used in product improvement, process engineering, strategic planning, and marketing.

In product improvement, the focus has tended to be on dematerialization, reducing

energy requirements, and minimizing waste. Over time, LCA has begun to encourage emphasis on the product design phase. The most widespread use of LCA for product improvement has been in vehicle manufacturing, where all the major MNCs now use the tool to reduce fuel consumption and minimize waste in manufacturing. There are a large number of other examples of LCA application to product improvement, the best known being cardboard and paperboard, plastics and chemicals, steel, aluminum, and nickel.[198]

LCA is also used extensively by corporations in process engineering to reduce wastes and improve efficiency. Data collected during LCA can be used as performance indicators for different stages of production processes. When LCA indicators rise, it shows that production is becoming less efficient, and it is also likely that costs are rising. When used in this fashion, LCA is an important component of the cleaner production initiatives that have made substantial strides in Asia and the Pacific.

LCA has also been used in the private sector as a strategic planning and marketing tool. There are examples of firms using LCA to integrate environmental aspects into strategic business planning and long-term product policy development to reduce the risk of "surprise" from tightening regulations or consumer demands.[199] The technique has also been used by firms wanting to substantiate environmental claims used in advertising and in eco-labeling schemes.

LCA Methodology

The rapid development of life-cycle analysis in the late 1980s brought with it the need for a consistent methodological approach. This task was originally taken on by the US-based Society for Environmental Toxicology and Chemistry, which proposed a four-stage conceptual framework in 1993.[200] This was later taken up by ISO as the ISO 14040 series of environmental management standards and came into common use in 1997. It is fair to say that this set of standards has become the de facto benchmark for LCA methodology.[201]

(i) ISO 14040 (1999) provides the general principles, framework, and methodological requirements.

(ii) ISO 14041 (1998) provides guidance for determining the goal and scope of an LCA study and for conducting a "life-cycle inventory." For example, the goal might be to compare two or more different products fulfilling the same function or to identify environmental improvement possibilities within the production process of a single product. Boundaries for assessment need to be set in relation to both geography and time. The inventory analysis step of ISO 14041 is the first significantly quantitative aspect. It involves developing an understanding of inputs (e.g., energy and materials) and outputs (waste). It measures clearly defined physical parameters. This step can be extremely time intensive as it can involve the collection of a large amount of data. Often manufacturing process types are similar, so databases of frequently used commodities for life cycle inventories can be helpful. Industry associations have published inventory databases for plastics,[202] aluminum,[203] corrugated board,[204] nickel,[205] and steel.[206, 207]

(iii) ISO 14042 (2000) provides guidance for conducting the "life-cycle impact assessment phase" of an LCA study. Sometimes, corporations using LCA will stop at the end of the inventory phase, especially if their interest is in process engineering and their intention is only to minimize the environmental costs of an existing production process. Most users of LCA want to go beyond inventory analysis, however, to investigate the actual environmental impacts of activities. This requires them to move on to the life-cycle impact assessment phase (ISO 14042) which involves going beyond data on inputs and wastes to estimating impacts on the environment. This step consists of impact classification (where inventory data are grouped and sorted according to impact categories); impact characterization (where the relative contribution of each inventory item to overall environmental risk is calculated); and valuation (where comparisons are made between the different impact categories through weighting and ranking procedures).

(iv) ISO 14043 (2000) provides guidance for the interpretation of results from an LCA study. It is the final phase of LCA where the results are subjected to sensitivity analysis, and then communicated to stakeholders.[208]

LCA and SMEs

The methodology for LCA outlined above can lead to quite complicated and time-consuming studies. As a consequence, there has been considerable discussion of the relevance of the technique to firms other than large multinational manufacturers.[209] While there is little in the way of generalizable published material on the success (or otherwise) of LCA, there is substantial business literature that points to the negative consequences of incorrect resource allocation decisions made by SMEs. It is argued that, if anything, LCA is even more important as the size of the firm decreases.[210] A recent Society for Environmental Toxicology and Chemistry (SETAC) report has suggested that the benefits to SMEs that take the complete life cycle of their products into account, include the following: [211]

- reduced operating costs via supply chain coordination of transport to reduce the fraction of vehicles traveling with light or empty loads;
- new product introduction by considering unused raw materials as a marketable asset rather than as a cost-centered waste stream;
- improved credit terms with financial institutions;
- reduced costs to certify to ISO 9001 and 14001;
- improved relations with regulators and reduced disposal costs.

Given the potential importance of LCA to SMEs, much recent academic research has focused on designing simplified methodologies and on the production of LCA-specific software. Most of these less time-consuming approaches use abbreviated matrix systems with environmental concerns along one dimension and life-cycle stages along the other.[212]

LCA in Asia and the Pacific

It is difficult to find reliable statistics on the uptake of LCA in Asia and the Pacific. Unlike EMS, where certifications are registered and ISO maintains good records of trends across countries, using LCA is less well recorded. In addition, many firms have developed customized versions of the technique and are reluctant to discuss them for fear of giving away a competitive position.

There is, however, a growing practical interest in LCA in some countries in the region. Probably the most active country has been Japan, where the Ministry of International Trade and Industry collaborated with the LCA Society of Japan and 250 corporations to study the methodology and applications of LCA during 1995–1997. This review resulted in the LCA Project funded in 1998 by the ministry to do the following: [213]

- establish LCA tools for the whole of Japan;
- construct a Japanese database;
- establish LCA application rules;
- establish education and communication systems.

There are also active LCA societies/ associations in the Republic of Korea (Korean

Society for LCA), and India (Indian Society for LCA). The Korean Society has been actively involved in a 5-year government project to develop methodology, 180 inventory databases, and case studies.[214] The Indian Society was inaugurated in late 1997 and has supported a detailed nationwide study of the steel sector.[215]

Other, more isolated examples of the use of LCA exist. A recent detailed study into the life-cycle impacts of paperboard manufacturing was made in Thailand.[216] Interest in the use of the technique has also been reported in PRC, Kazakhstan, and Viet Nam.[217]

Environmentally sound product designs not only include LCA but also techniques to help designers improve the environmental performance of their products. The most common aspects addressed are (i) recycling, (ii) disassembly, (iii) energy efficiency, (iv) remanufacture, (v) disposability, and (vi) minimizing the use of hazardous materials. Product designs play a crucial role in innovation and creating products that meet consumer demands for environmentally sound goods and services.

ENVIRONMENTAL MANAGEMENT ACCOUNTING

The techniques outlined so far are all focused on improving managerial control of environmental impacts. In varying degrees, the techniques require that environmental costs be accounted for which has led to the development of a new discipline known as “environmental management accounting” (EMA).[218] This new field provides reports for both internal use (generating environmental information to help make management decisions on pricing, controlling overhead, and capital budgeting) and external use (disclosing environmental information to the public and to the financial community).[219]

This report focuses on EMA for internal use. EMA involves the identification, collection, estimation, analysis, and internal reporting and the use of material and energy flow information, environmental cost information, and other cost information for both conventional and environmental decision making within an organization.[220] It is a more comprehensive approach to management accounting with a particular focus on costs related to wasted raw materials and other environmental issues.[221]

EMA can trace its historical development back to the 1970s where it began as a subset of social responsibility accounting. Since that time, it has progressed through three stages. In the 1980s, debate focused on the role of accounting in disclosing information on environmental activities. The period from 1990 to 1995 saw a maturing of the discipline of making environmental disclosures and in launching environmental auditing. Since 1996, EMA has been increasingly viewed as measuring environmental performance exceeding regulatory standards.[222]

EMA has developed strongly over the last 15 years. The competitive global market has driven the need for operational and material efficiency gains, and there is a growing need to deal with increases in costs for raw materials, waste management, regulatory compliance, and potential liability. EMA use has also been driven by the increasing pressure on business to improve overall environmental performance, and accountants and business managers have begun to see the limitations of some conventional accounting approaches for the management of environment-related costs. The following conventional management accounting practices might, for example, contribute to the inadequate consideration of environmental costs in internal decision making:

- unintentional "hiding" of many environmental costs in overhead accounts;
- inaccurate allocation of environmental costs from overhead accounts back to processes, products, and process lines;
- inaccurate characterization of environmental costs as "fixed" when they may actually be variable (or vice-versa);
- inaccurate accounting for volumes (and thus costs) of wasted raw materials;
- actual lack of inclusion of relevant and significant environmental costs in the accounting records.[223]

As an example of the last point, traditional accounting would allocate only a small proportion of the total costs of waste incineration while the vast majority of costs would be hidden. EMA thinking suggests that total costs are like an iceberg, with most not seen. Examples of hidden costs might include (i) energy costs of waste materials, (ii) purchase costs of waste materials, (iii) costs of additional storage space for waste, (iv) processing costs of wasted materials, (v) labor costs of processing waste and wasted materials, and (vi) administrative costs of processing waste and wasted materials.[224]

Numerous case studies now exist of the application of EMA in corporate activities. A recent article listed around 100 examples from 9 reports published in the period 1998–2003.[225] While most of these cases are from developed countries, there are a growing number of examples from Asia and the Pacific. Much of this work has been sponsored by international agencies. The UN Division for Sustainable Development has supported an international expert working group on EMA, and guidance and case studies can be found online.[226] A substantial amount of resource material has also been collected by USEPA and now resides with an independent organization known as the Environmental Accounting Research and Information Center. Networks of EMA practitioners have begun to establish their presence, and the EMA Network (Asia/Pacific) that was established in 2001 has 14 member countries (Australia; PRC; Hong Kong, China; India; Indonesia; Japan; Republic of Korea; Malaysia; New Zealand; Philippines; Singapore; Taipei,China; Thailand; and Viet Nam).[227] Finally, a German international human resources development agency known as InWent has begun a 4-year project to build EMA capacity in Southeast Asia in conjunction with a range of Asian partner organizations.[228]

In conclusion, it is likely that clever corporations will begin to recognize that the distinction between conventional management accounting and EMA is blurred and that the two are merging into a single broad management accounting approach that can better inform all decisions, environmental and otherwise.

FINAL WORDS

All of the environmental management tools outlined in this chapter have been developed and tested over the past 15 years by corporations as methods for improving their own environmental performances. While industry associations and governments have had some involvement in these initiatives, most have been individual experiments by corporations acting independently. A positive outcome has been the development of a sense of ownership, where corporations have seen the benefits of the tools and have refined and adapted them for their own purposes.

The tools vary in the extent of their use. Corporate environmental reporting and EMS have been widely accepted and standardized to the point where there is a worldwide understanding of how these two initiatives should be implemented. The same cannot be said of environmental management accounting and life cycle analysis, where the techniques are less well developed and general applicability is less sure.

It is certainly clear that the necessary tools are already available for Asian and Pacific corporations to take responsibility for the management of their own environmental impacts. As time passes, the tools are being

further refined and made more relevant to the needs of smaller firms and of specific industrial sectors. It is no longer possible for corporations in the region to argue that they do not have the techniques available to improve their environmental management. In fact, failure to adopt the methods and approaches outlined in this chapter will eventually threaten the competitiveness of reluctant firms as relative productivity declines, corporate reputations suffer, and asset values fall as a consequence.

CHAPTER 5

Turning Threats into Opportunities

Proactive corporations that adopt emerging sustainability tools will be in a good position to turn what have been considered environmental problems and constraints into profitable outcomes. Generally, business managers have an obligation to shareholders to make environmental investments when they deliver positive returns or reduce risks. The increasing awareness of such opportunities shows that it makes sense for corporations to integrate environmental considerations into their business thinking.

Many attractive opportunities for beyond-compliance behavior by firms are outlined below. Firms in all sectors can add to profitability and improve their environmental performance by focusing on (i) eco-efficiency, (ii) recycling, iii) cleaner production (iv) continuous improvement processes, (v) energy efficiency, and (vi) investing in new technology. For corporations producing products for retail sale, market share also can be gained by enhancing brand name recognition through eco-labeling and certification.

In addition, there are expanding demands for (i) new environmental infrastructure such as water supply and wastewater treatment systems; (ii) renewable energy; (iii) environmentally preferable products, (iv) environmentally sound primary production, and (v) environmental services including design, engineering, laboratory analysis, monitoring, auditing, and reporting. Collectively, these business opportunities are referred to as "environmental goods and services."

PROFITING FROM RESPONSIBLE ENVIRONMENTAL MANAGEMENT

There are many ways firms can add to their profitability and improve their environmental performances by focusing on clean production practices and energy efficiency and by investing in new technology.

Eco-efficiency

The starting point for business renewal is the concept of eco-efficiency, also referred to as "cleaner production." Eco-efficiency has been defined as "…achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity."[229]

This may appear, at first glance to be a difficult concept and goal since it refers to the Earth's carrying capacity, a term that still has no precise definition or estimation. A simpler definition identifies seven elements or steps that companies can use to improve their eco-efficiencies:

(i) reduce material intensity,
(ii) reduce energy intensity,
(iii) reduce dispersion of toxic substances,
(iv) enhance the ability to recycle,
(v) maximize use of renewable resources,

(vi) extend product durability, and
(vii) increase service intensity.

It is relatively easy for any company, no matter where it is on the road to environmentally sustainable behavior, to begin implementing these seven steps immediately. This should appeal to pragmatic business executives since the first measures usually begin by reducing wastes and increasing profit. Why use expensive and dangerous toxic chemicals when you can find safer and less expensive substitutes in processing? For example, electronic chip manufacturers were delighted to discover that high-pressure water properly directed could clean their product just as effectively as costly freon chemicals that posed a threat to the stratospheric ozone layer. Likewise, when employees or engineers find ways to reduce a company's energy requirements, the cost savings go directly to the bottom line.

One remarkable paradox is that companies with the worst environmental performance generally stand to benefit the most from eco-efficiency improvements. They are throwing valuable product out the door when they discharge waste products into the air, water, or landfills. For example, leather tanners traditionally use chromium in the degreasing stage and then dump the waste into nearby water systems. Recycling the waste to recapture this potentially toxic chemical reduces the need to buy the costly product in the first place. The savings quickly exceed the cost of investment in the recycling equipment, and the aquatic environment benefits since the toxic metal never enters natural systems. In this way, the company reduces its operating cost and increases its profit margin while protecting the environment.

Contrary to end-of-pipe pollution treatment, eco-efficiency often pays handsome dividends. One major US-based MNC initiated a pollution prevention pays program as early as 1975—long before the term eco-efficiency was coined. By 1992, the firm claimed that it had saved more than $750 million on over 3,000 programs to prevent or reduce pollution. Another US MNC launched a program called Waste Reduction Always Pays in the early 1990s. The company claims that they have had annual savings equal to twice their investment costs (a payback period of less than 6 months) and very high return on investment for waste-reduction projects. Once the investment costs have been recovered, the benefit to the company continues almost indefinitely and contributes positively to corporate profits. The same firm announced that it planned to spend $1 billion to achieve new internal environmental, health, and safety targets over the next decade—including waste-reduction initiatives—and that it expects to generate a return on investment of 30– 40%.[230]

A major Japanese electronic firm developed a new exchange and refurbishing program for the repair of digital products. Since the inception of this program, costs have been reduced by 25%. Another Japanese company developed an eco-cement process that uses waste from society and other industries and in which dioxins and harmful heavy metals are captured. The toxic chemical wastes with energy value are completely destroyed in the cement kilns due to the high temperature and long residence time in the burning chamber. The trace metals are immobilized within the final cement product. Through the manufacture of eco-cement, the company conserves energy, reduces its fuel costs and reduces carbon dioxide emissions.

Eco-efficiency is not only happening in big companies in the developed world, it is also very relevant to SMEs in developing countries. In Colombia, a food producer of oil and butter invested in a process change to reduce water use. The investment costs were recovered in less than half a year. A printing company in the same country replaced traditional toxic solvents with others that are less environmentally harmful. This action reduced the environmental impact of toxic by-products by 75% and lowered the cost of solvents to the firm.

Eco-efficiency is indispensable in today's knowledge-based economy for four main reasons:

Box 4: How Eco-Efficiency Pays Off for Some Firms

A recent study conducted by a UK group called SustainAbility, examined the business case for sustainability in developing countries. Through a broad survey of over 170 companies—small businesses to multinational corporations—in over 60 countries (including in 14 Asian countries), the study makes the case that sustainability is about increasing the opportunities for businesses in emerging markets, not limiting them.

Economic Gains in Thailand

One example of realizing cost savings from eco-efficiency measures comes from Thailand. By focusing on the contribution of voluntary low-cost or no-cost cleaner production practices in industrial productivity and on profitability, the Samut Prakarn Cleaner Production for Industrial Efficiency (CPIE) Project helped more than 600 organizations, including 423 manufacturing industry members achieve enhanced eco-efficiency.

The total estimated after-tax net savings to program participants from water, wastewater, and electricity reductions over the period 2003-2007 produced a Net Present Value of 390 million Thai Baht (US$ 9.3 million). Given the project budget of approximate 273 million Thai Baht (US$ 6.5 million), these savings result in a 47% financial rate of return. The project also generated significant benefits to the Government of Thailand and Thai society. The estimated values of these benefits over three and a half years were:

- 44 million Thai Baht (US$ 1 million) per year in increased tax revenue;
- 8.3 million Thai Baht (US$ 200,000) per year in industrial productivity gains;
- 2.8 million Thai Baht (US$ 70,000) per year in saving from reduced greenhouse gas emissions; and
- 8 million Thai Baht (US$ 190,500) per year in savings from reduced land subsidence

Product Differentiation in India

Environmental process improvements can also lead directly to increased revenues. One example is Century Textiles and Industries Limited, an Indian company that produces high-quality cotton textiles and yarn, viscose, and rayon. Following the German ban on azo dyes in 1993, one of Century's major German clients sent details of new requirements to guarantee environmental performance, which essentially meant that Century had to meet the independent Eco-Tex standard. As a result, the company had to substitute many of its dyes, which led to a 10-15% cost increase in most of the shades. However, a resulting optimization of the dyeing recipe led to a 20-30% cost saving in two of the most popular colors. More importantly, certification brought several market advantages. The marketing department could get an 8-10% premium rate due to the Eco-Tex label and overall quality improvements. Additionally, the market widened by at least 10% in the first year alone, as many new buyers turned to Century due to the Eco-Tex certificate.

Enhanced Brand Value in India

A company's reputation is an intangible asset that helps to build sales, attract capital, and business partners, and recruit and retain workers. On the strategic side, this means building a brand, while on the defensive side, it means managing risk. One example of the former is provided by Wipro, an Indian IT outsourcing firm. The company's clients include NEC, Nokia, and BT, all companies that adhere to the comprehensive reporting guidelines recommended by the Global Reporting Initiative. To win acceptance as a major supplier, the company has carefully built up its brand by being green and by taking up socially relevant initiatives. The company follows the pattern of a growing number of companies in Asia and the Pacific that are getting the attention of global markets and lowering its cost of capital by reporting with a high level of transparency and making the effort to install and report socially responsible policies. In 2001, the company posted a 106% rise in net profits to US$138 million on revenues of US$662 million, this at a time of a worldwide downturn in the high-tech service industry.

Sources: UNEP. 2004. *Regional Sustainable Consumption and Production Report: Asia and the Pacific.* Paris, France; SustainAbility. 2002. *Developing Value: The Business Case for Sustainability in Emerging Markets;* Lincoln, Adam. 2001, September. For Good Measure. *CFO Asia.* Hong Kong.

(i) *Dematerialization* which involves companies substituting knowledge flows for material flows. An optional route is product customization—less waste is generated when manufacturers make the precise product ordered by the consumer.
(ii) *Closed-loop production* in which nature

provides a role model for sustainability. The objective is to move toward closed-loops and zero discharge where any output is returned to natural systems as a nutrient (not a pollutant) or becomes the input into another manufacturing process.

(iii) *Service extension* through which consumers are increasingly gaining access to product services by leasing goods rather than buying them outright. The manufacturer or distributor takes back the product and refurbishes it for continuous reuse.

(iv) *Functional extension* which means Designing smarter products that deliver improved service to customers. The products deliver more value with less waste, less energy consumption, and lower total cost.

Eco-efficiency has been criticized for not addressing or achieving all the goals of sustainable development, but it was never meant to serve as a total solution. It allows business to do what it does best—meet society's demands for goods and services while improving the efficiency of operations—and deal with traditional pollution and environmental issues. It is a first logical step on the journey to sustainability. In OECD countries, companies that have adopted eco-efficiency generally go on to explore their behavior with respect to social and more complex environmental issues such as global warming. Convincing all businesses, large and small, to adopt eco-efficiency would make huge gains in environmental quality at the local level and the micro (factory) level. This strategy would also buy more time to build the broader consensus needed to address pressing global and macro issues.

The toolkit for identifying eco-efficiency opportunities is well developed. In 2000, a group of companies issued a report to assist in measuring and reporting on eco-efficiency. The framework provides a common set of definitions, principles, and indicators.[231] It is flexible enough to fit individual needs of companies across the business spectrum. Business leaders in Asia and the Pacific have a host of examples of companies implementing eco-efficiency, and best practices are available on a number of websites. There is also a measuring and reporting framework in place to assist them in getting started. Thus, there is a ready-made road map for those willing to start the journey toward sustainability.

Recycling

Recycling is one key component of eco-efficiency, and cost-effective opportunities through recycling are numerous. It should not be thought of as just picking through someone else's waste as it is integral to technological development and innovation. As one example, in the 1960s and 1970s, abandoned cars littered city streets and rural road margins all over the US and many other OECD nations. There was a host of useable materials in those "junkers" even after the used parts were stripped away. Entrepreneurs soon began collecting old vehicles, ripping them apart, and using electro-magnets to extract the ferrous metals. The perfection of the basic oxygen furnace, able to remelt old ferrous metals, made it possible to recycle a wide range of iron and steel products. New mini-mills creating iron rebar and other products soon became a threat to the older integrated steel mills in the US and led to the closure and downsizing of many polluting coke ovens and 19th century steel ovens. The net effect was a rapid turnover in the capital stock of the US steel sector, significant reductions in pollution levels, and lower demand for the raw materials to feed the old, inefficient factories.

European legislation such as the Waste Electrical and Electronic Equipment Directive and the Restriction of Hazardous Substances Directive, which are due to be in place in 2006, as well as the End-of-Life Vehicles Directive (which took effect in 2003) all present increased opportunities for metal recycling. The market for ferrous and nonferrous metals in the UK was estimated at 5.5 million tons in 2003, valued at $3 billion.

From the beginning of 2005, Japan has 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 CFCs, 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.[232] It is not clear if the export of secondhand vehicles from Japan will also be prohibited.

New ways of dealing with products at the end of their useful lives can be related to increasing sales of functional services rather than products. For many products, the trend is toward leasing rather than purchasing. The manufacturer or the dealer retains control of the equipment or product and performs the routine maintenance. Leasing is not a guarantee of eco-efficiency, however. For cars, dealers may still offload older vehicles to the poor and the cycle of deterioration may only be delayed, not ended. Many car hire companies in Australia, for example, compete on price with "rent-a-bomb" approaches—recycling secondhand cars that are well past their primes. This demonstrates the need to combine market-based approaches with effective regulation to ensure that the vehicle fleet is optimally recycled.

As another example, a major producer of mobile phones has instituted a "take-back" scheme for its products throughout Asia and the Pacific. Customers are encouraged to dispose of their used or old mobile phones, batteries, and accessories by utilizing 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 including in PRC; Hong Kong, China; India; Indonesia; Malaysia; New Zealand; Philippines; Singapore; Taipei,China; and Thailand. 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 collected are recycled in a safe and environmentally friendly way. It now has more than 120 recycling points in the region.

Since 2001, computer manufacturers in Japan have been required to recycle computers from businesses, and since 2003 to take back used personal computers. A network of collection centers has been set up utilizing the 20,000 offices of Japan Post. About 500,000 computers (about 9,000 tons) are scrapped each year. A fee to cover the cost of recycling (about $30–$40) now is added to the price of the computer at purchase.

Facing significant shortages in available waste disposal capacity (only 3.9 years of industrial landfill space remained in Japan in 1999), the country sought to reduce waste and improve its material balance by increasing recycling, passing the Basic Law for Promoting the Creation of a Recycling-Oriented Society in May 2000 (see Box 5). This law built on earlier legislation in 1991 entitled the Law for Promotion of Effective Utilization of Resources (often referred to as the Recycling Promotion Law). Under the umbrella of the basic law, Japan has also passed laws on (i) container and packaging recycling, (ii) electric household appliance recycling, (iii) construction material recycling, (iv) food recycling, and (v) promoting green purchasing.

The total size of the recycling market in Asia and the Pacific is difficult to estimate since much recycling remains unrecorded. For example, the PRC imports about 3 million tons per year of waste plastic and 15 million tons per year of waste paper and cardboard, but this forms a small percentage of the total amount recycled. For the exporting nations, waste exports reduce the amount of landfill space needed and generate revenue. For the importing nations, waste materials are a cheaper source of raw material and can often be reexported after processing. One of the major factors driving the economics of this trade is the large volume of empty containers returning

from the PRC's exports to the developed world, reducing the transport cost to very low levels. In Thailand, about 22 million tons per year of solid waste is generated of which only about 11% is recycled.[233] In India, the Municipal Solid Waste Management Rules 2000 require all municipal bodies to compost city wastes and set a deadline for establishing facilities by December 2003, but there has been little action to date, unfortunately.[234] In Manila, Philippines, of the almost 6,000 tons of solid waste generated every day, only about 6% is recycled.[235]

A word of caution applies to the recycling concept. The recycling of many older finished consumer products, especially electronic and computer equipment, may require extensive deconstruction "handwork." As a result, consumer trash is often shipped from the developed to the developing world to take advantage of lower labor costs. Around 500 million tons of toxic wastes are estimated to be exported to developing countries every year.[236] Too often, however, the 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. Over time, these practices should become less prevalent as manufacturers design for ease of recycling, use fewer toxic materials, and take more responsibility for the final disposal of their products. In the near term, however, this sort of recycling will continue to present health and safety issues to developing countries in the region.

As one example of likely future trends in response to these concerns, the parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal decided in October 2004 that obsolete ships slated for recycling in countries like Bangladesh, India, and Pakistan can be considered toxic waste under international law and that their export must be controlled under the terms of the convention. Hazardous components in recycled ships include asbestos, polychlorinated biphenyls, toxic paints, and fuel residues. As thousands of ships are scrapped each year, shipbreaking countries can now demand that all of these toxic materials be removed before the ship is sent to a breaking yard.

Despite these cautionary notes, the market for recycling in Asia and the Pacific is likely to continue to grow, and it can be a very profitable industry. The largest waste management company in the US has revenues of over $12 billion per year.[237] There are very rough estimates of the potential in Asia and the Pacific. If recycling rates could be easily doubled to 20% of the waste generated, and if future waste generation will reach European levels of about 1 ton per person per annum, at a conservative value of $80 per ton, the potential for the Asian recycling market is around $320 billion per year.[238]

Box 5: Japan's 3R Initiative: Reduce, Reuse, Recycle

Japan is taking a leading role in Asia and internationally in promoting a circular economy based on applying three key principles to: reduce, reuse, and recycle. Prime Minister Junichiro Koizumi proposed the "3R Initiative" at the G-8 summit on Sea Island, Georgia in 2004, and received much support from the other G-8 country leaders. The first of its kind, the 3R Initiative was formally launched at a Ministerial Conference held in Tokyo in April 2005 with the participation of 21 countries.

Confronted by rising pollution in the midst of rapid post-war economic development, Japan began strenuous efforts for environmental conservation in the 1970s. Starting in 2000, it embarked on a full-scale effort to pursue a sound material-cycle society. Three key factors provided the impetus for Japan's domestic 3R Initiative to achieve a "Sound Material Cycle Society": (i) the high volume of wastes being generated, (ii) rapid industrial development, and (iii) the country's limited land mass. To create "a sound material-cycle society in which there is a simultaneous pursuit of both environment preservation and economic development," Japan enacted an associated Fundamental Law and formulated a Fundamental Plan to establish a Sound Material-Cycle Society, with quantitative targets set for 2010.

At the 2005 conference, the Government of Japan proposed an action plan for Japan and other East Asian countries to cooperate in creating a recycling-oriented community in the region by 2012 and to promote zero-waste societies. The plan also states that Japan will set up a research network locally and abroad for the exchange of information on technological development and the study of social systems concerning waste control in the region.

Based on its own experience and technological capabilities, Japan is in a good position to support capacity building for establishing sound material-cycle societies in developing countries and to strengthen international cooperation to realize worldwide zero-waste societies.

Source: 2005. *Japan's Action Plan for a World-Wide Sound Material-Cycle Society through the 3R Initiative.* http://www.env.go.jp/earth/3r/en/approach.html

Cleaner Production

Dematerialization can also be achieved through eco-efficiency on the factory floor. Henry Ford, the founder of the modern automobile assembly line, would not recognize the automobile factory of the 21st century. The first difference would be the general level of cleanliness. Early auto plants were hot, dirty, dusty, greasy, and generally unpleasant environments in which to work. Today, the shop floor is painted in bright colors so that any residual waste cries out for attention, but the greatest shock to Ford would be the omnipresence of robots spot welding, painting, and conducting other mechanical functions with a degree of precision and speed that not even the best-trained and most highly motivated employee could match. The implications for just one part of the process—painting—illustrate these changes.

Ford is famous for saying that consumers, "…could have any color car they wanted, so long as it was black." Today, cars come in all the colors of the rainbow, but the greatest difference is how they are painted. Previously, they were painted by hand or dipped into vats of paint by manned equipment. In other cases, workers wearing masks and respirators sprayed the paint onto vehicles and parts. Plant managers were happy if the final product passed the superficial quality check at the end of the process. Less than 50% of the paint ended up on the cars or parts. The rest escaped into the air or was poured onto the ground—eventually flowing into adjacent waters. Factory managers did not care because paint was cheap and disposal was even cheaper. Contrast that with the process for painting new cars today. The parts or entire vehicles enter a sealed chamber. No human needs to be in that unfriendly but highly controlled environment. Robots are preprogrammed to apply paint in precise quantities to precise locations. Ninety-five percent or more of the paint goes onto the car and not down the drain. There are zero uncontrolled emissions to the air. The little that "goes down the drain" is captured, recycled, or sent to treatment. Managers are now rated by how little paint they waste. The environment is protected from both effluents and emissions.

There is one other difference related to automobile paint. Beginning in the 1950s, manufacturers of quality cars began using oil-based paints that enabled them to produce a higher gloss and a glistening finish that would last longer. Customers demanded this better-looking product. The problem was that oil-based paints were more toxic, harder to treat, and ultimately, more damaging to the environment. Working with paint manufacturers, the automobile industry finally developed a paint product and an application process that enabled them to obtain the desired premium finish using water-based paints which have two advantages over oil-based paints: they are both easier to recycle and to treat before being discharged into wastewater. Thus, productivity-enhancing innovation helped to meet several of the criteria of eco-efficiency.

To take another example, in the 1960s, the pulp and paper industry was an energy-intensive, dirty industry everywhere in the

world. The entire sector was very water intensive, and odors associated with pulp and paper mills could be detected tens of kilometers away from the mill, depending on the prevailing winds. In chemical pulping, the largest portion of production, the residue of so-called "black liquor" (the spent wood-digesting liquid) was discharged directly in adjacent water bodies. Where the dilution factors were low, the environmental results were disastrous to aquatic ecosystems. By 2000 in OECD countries, the "black liquor" was recovered and used as a fuel along with bark and other wood wastes in virtually every mill. On average, modern pulp and paper mills derive 60% of their internal energy requirements from renewable wood by-products. This percentage increases each year as plant managers strive to be more efficient. All effluents are treated before discharge, and the sector is no longer considered a dirty industry. Water consumption in new plants and modernized facilities has dropped by 70% in the past 40 years. Total energy consumption within the industry has increased as demand for its product has grown, but the sector improved its energy efficiency by an average of 1.6% per year from 1971 to 1991.[239]

Several new paper mills using world-class Scandinavian technology have been constructed in the PRC. As a result, and partly driven by environmental concerns, several hundred smaller paper plants using outdated technology have closed since these new mills were introduced. Pollution loadings from the pulp and paper sector have dropped significantly along several river segments. One unwanted side effect has been the displacement of workers, since the new plants are more highly automated and require fewer workers per unit of output. This may be inevitable as new cleaner technology replaces older, highly inefficient, polluting methods. Many of these new mills also incorporate elaborate wastewater treatment facilities. There is the risk, however, that plant managers may short circuit these pollution systems to save energy costs. Business managers should be aware that in the new information age, their actions will soon become known and the firms will increasingly be subject to government fines and consumer boycotts. On the other hand, those firms that adopt eco-efficiency will be recognized as environment-friendly, will build customer loyalty, and will increase market share over time.

A more fundamental concept for the modern plant is one that follows "closed cycle" principles or zero emissions. In a closed cycle, a processing plant takes in freshwater and never discharges any liquid effluents back into the natural environment. The water is constantly recycled or imbedded in the final product itself. This means that there is zero water pollution. The closed cycle is, however, difficult to obtain for many raw materials and industrial processes. So-called industrial ecology solutions that involve using waste from one industrial process as the feedstock for another are an increasingly attractive and cost-effective option. For example, waste slag from steel production is being used as a feedstock in the cement sector. Other by-products from production processes can be used as flocculants in treating wastewater before it is discharged back into the natural environment.

Industry sources report that there are over 160 small aluminum smelters in the PRC,[240] but it would take only five or six modern state-of-the-art aluminum smelters to produce the same output with significantly less negative environmental impact. Such a consolidation would, however, result in a tremendous loss of employment since the new plants are far less labor-intensive. Over time, the market forces of globalization and international competition will drive the aluminum industry and other producing sectors relentlessly in this direction. Governments, civil society, and business will need to work cooperatively to manage the transformation while creating new employment opportunities and retraining displaced workers.

There are significant business opportunities in new clean technology investments in Asia and the Pacific (see Box 6). Venture capitalists, those most interested in seeking profits through innovation, are already focusing attention on clean technology. Mainstream venture capitalists have entered the sector, backing everything from solar cells and lithium ion batteries to software that boosts manufacturing efficiency.

Institutional investors like the Public Employees' Retirement System and the State Teachers' Retirement System are being pushed by the California State Treasurer to invest a combined $1.5 billion in green technologies as part of his "Green Wave" initiative. The California Public Employees' Retirement System pledged to invest $200 million in environmental technologies and later decided to invest another $500 million in environmental mutual funds or direct investments to fund managers with an environmental focus. Getting part of these funds invested in Asia and the Pacific is both a challenge and an opportunity for the region's corporations.

Box 6: Introduction of Cleaner Technologies in Tanneries in Pakistan

The Cleaner Production Centre (CPC) at Sialkot is run by the Pakistan Gloves Manufacturers and Exporters Association. Its objective is to control the indiscriminate discharge of potentially harmful solid waste and heavily polluted wastewater and improve working conditions in the tanneries through the introduction of in-house cleaner production techniques.

The cleaner production measures introduce included water conservation measures, and the introduction of desalting tables, dust collectors, and screen grit chambers. Water flow meters were installed in 125 tanneries, allowing the tanneries to monitor water consumption and reduce water use wherever possible.

The environmental and economic benefits of these measures have included the following:

- a 23% reduction in the total volume of water used;
- lower electricity consumption (a reduction of 6,400 kWh per month);
- 40% reduction in salt use;
- screen grit chambers reduce suspended solids in effluent by 70-80%, and chemical and biological oxygen demand levels by 20-30%.

The Introduction of Cleaner Technologies in Tannery Clusters of Punjab (ICTP) project was launched by the Pakistan Tanners Association (Northern Zone). ICTP focuses on the implementation of physical in-house pollution reduction measures and technologies in target tanneries. The cleaner production measures that were introduced included desalting, lime float recycling, tanning float (chrome) recycling, setting up of process control laboratories, water conservation measures, and primary treatment systems for effluent. The results achieved by adopting many of these measures were similar to those achieved by the Sialkot CPC.

Quantified environmental benefits of setting up primary treatment systems for effluent led to the following results:

- 50% reduction in total suspended solids;
- 37% reduction in chemical oxygen demand;
- 32% reduction in total dissolved solids; and
- 30% reduction in sulfates.

Source: ADB. 2005. *Technical Assistance to Pakistan for Industrial Environmental Management Capacity Building, Final Report, Part A: Policy Reform and Institutional Capacity Development.* Manila.

Continuous Improvement

The industrial firms, partnerships, or consortia that will capture future markets are those committed to a process of continuous improvement. Each new factory must incorporate state-of-the-art technology—and this includes full integration of environmental management into production—to meet the demands of the global market. Modern managers recognize that today's best plant, on average, will begin to lose its relative competitive advantage within 5 years and will need modification. The life cycle for a physical plant and equipment varies from industry to

industry but the lesson is the same for all. For example, every major oil refinery in the world is completely rebuilt every 20 years if not more frequently. Each new or modernized refinery manages to extract more high value end product from every barrel of crude oil refined and to reduce the unit of pollution (lost product) at the same time. Routinely, every part of the barrel of crude is used either as an energy input in the cracking or refining process or as a saleable product. There are two primary objectives. The first is to constantly reduce the amount of energy used in the process and not available for sale. The second is to produce more high-value products and fewer low-value products, such as tar used in road construction. Further, the newer plant invariably reduces the risk of accident or process upset. Hence, risk reduction is an inherent feature of continuous improvement.

The concept of continuous improvement applies not only to large industrialized firms but to those in the consumer goods and services sector and eventually to SMEs as well. The new globalized and knowledge-based economy requires flexibility, innovation, and continuous education not only of managers but of employees as well.

Another component of continuous improvement is the environmental design of products. Innovative firms are constantly redesigning products to produce more economic value and less negative impact on the environment. The evolution of a function as simple and basic as clothes washing is instructive. When it became clear that phosphates, an additive to enhance "whiteness and brightness" of washed clothes, were contributing to the eutrophication of inland water bodies, the detergent industry found substitutes that eliminated phosphates while retaining the effectiveness of the product. Then when LCA revealed that the greatest environmental impact from washing clothes was the energy used to heat the wash water, detergent manufacturers engineered their product to be equally effective using cold water. Washing machine manufacturers modified their equipment to permit users to use the cold water cycle, reduce energy costs, and still obtain the desired quality of cleaning. Detergent producers also reduced packaging and provided consumers with concentrated product to provide an alternative product choice.

In another illustration of the sequential gains of continuous improvement, a pigment manufacturer in India has used innovation and technology to continuously enhance both its economic and environmental performance. Rather than neutralizing it with lime and sending it to landfill, the firm first converted its waste from its green pigment plant into a sellable by-product, aluminum hydroxide, used in antacid formulations in the pharmaceutical industry. This required an investment of $1.4 million with a payback period of 3 years. Second, they used a chemical process to strip out the ammonia content in effluent from the plant's blue pigments to create a residual by-product that is also an essential raw material used at the aluminum hydroxide plant. For this, the capital investment was $200,000 with a payback period of only 11 months. Third, they encouraged waste reduction by helping suppliers to change the packaging (polyethylene bags, high-density polyethylene bags, and paper or plastic containers) used to deliver raw materials. As a result, the quantity of waste generated through packaging materials has been reduced to a negligible amount. This latter program required a small investment of $100,000 with a payback period of 1.5 years.[241]

Energy Efficiency

Energy production to power industrial processes or to generate electricity poses difficult issues. While it is possible to capture many of the traditional pollutants from fossil fuels—particulate matter, sulfur dioxide, and nitrogen dioxide—through innovative technologies, options for reducing or recycling the primary GHG, carbon dioxide, pose new difficulties for industry. From the beginning of the industrial age, carbon dioxide has not been regulated as a pollutant, since it was used by trees and other vegetation and was not seen as posing any direct threat to humans. Today, as emissions of carbon dioxide exceed the ability of natural ecosystems to recycle this ubiquitous GHG, industry and society must find ways to limit its emission or to increase its sequestration and absorption. Greater reliance on nonfossil fuels—including hydro-electricity, geothermal wind, solar, nuclear, and biomass—can all contribute to slowing the growth of carbon dioxide emissions from fossil fuel combustion.

However, energy efficiency improvements are often the easiest, cheapest, and most cost-effective way to reduce carbon dioxide emissions. As the cost of oil and other fossil fuels continues to rise faster than the rate of general economic growth, all sectors of industry have an increased incentive to conserve energy—especially energy derived from fossil fuels. Until the oil price shocks of 1973 and 1979, there was a strong linkage between economic growth and energy consumption rates. For OECD countries, the economy grew 17% between 1980 and 1998, with energy use falling by about the same percentage, but when world market prices for oil plunged back under $20 per barrel, interest in energy conservation waned. Beginning in 2004, as the international price of crude hit new highs, there was again an even greater incentive for industry to conserve and produce more economic value for every unit of energy input. This is at the core of the argument for the rapid turnover of existing capital stock; phasing out older energy-inefficient processes and introducing either more efficient fossil fuel energy or nonfossil fuel alternatives.

Electric motors consume 65% of all energy used in industry.[242] Traditionally, these motors ran at a constant speed. Now manufacturers are providing variable speed motors that allow producers to "follow the load" and eliminate wasteful use of energy. Further, every improvement in the efficiency of electric motors reduces energy costs for manufacturers. Businesses that invest in these new, more efficient motors usually obtain a payback within months or a few years at the outside. In a similar vein, jet engines that power modern commercial aircraft have increased their fuel efficiency dramatically since their introduction in 1958. This improved energy efficiency was achieved simultaneously with significant reduction in sound levels and reduction of the black smoke from unburned hydrocarbons that were a characteristic of the early jet turbine engines. Modern jet engine technology is now used in the production of the so-called low-head hydro turbines that can generate electricity from small run-of-the-river systems with virtually no adverse environmental impacts. These new efficient turbines can be used in small-scale applications in rural settings to bring electricity to otherwise unserved areas or to replace inefficient diesel generators that are expensive and produce unwanted GHGs.

Turning Over Capital Stock

For the past 35 years, there has been a relentless trend toward use of cleaner production processes. Whether the product is electricity, steel, paper, chemicals, or other commodities, industry has found new and improved manufacturing and processing systems that produce products using fewer natural resources and generating less pollution per unit of output. Often, the driving force has been to avoid new environmental regulations or simply to find ways of meeting or exceeding environmental targets at a lower cost rather than adding on pollution control technology at the end of the production process. In most cases, the total cost, including capital and operating and maintenance costs, is lower for the new cleaner production process. Thus, there is a clear economic incentive to invest in new technology thereby improving or maintaining the competitiveness of the individual firm. Society and the environment are beneficiaries of this investment especially when the older, more resource-intensive and polluting factories are closed.

However, closing of older facilities and turning over the capital stock is neither automatic nor guaranteed. Some owners or managers seek government protection from firms investing in the

new technology under the guise of protecting jobs and the local economy. Alternatively, they claim that they cannot afford the capital investment to replace or modernize existing facilities. Governments can use regulation or economic incentives to encourage companies to close out-of–date facilities on a timely basis. Accelerated depreciation of new clean technology, for example, is a powerful tax incentive to encourage investment in clean technology.

To take one example, making steel is an energy- and resource-intensive process. In the conventional blast furnace method, iron ore must be processed in a sintering plant and the coal first must be converted into coke. Both of these processes generate large quantities of air pollutants that are difficult to control. A completely new "finex" process that eliminates the sintering and coking processes reduces sulfur oxide emissions by 92% and nitrogen oxide emissions by 96%, as well as requiring less capital. Unfortunately, older blast furnaces can operate for 50 years, so it will be decades before the old blast furnace technology will be phased out everywhere. Governments will need to work with industry to ensure that the older polluting capital stock is turned over in a more reasonable period, but at least there is an economic incentive to do so.

Turning over the capital stock is more difficult in cases where the new cleaner technology is more, rather than less, expensive. For example, in 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. In almost every country, governments determine and regulate the price or electricity. 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 bargain to reduce environmental pollution from the electricity-generating sector. The recent innovation in Europe of encouraging consumers to pay a small premium for energy generated from renewable sources is a good example of how all stakeholders can work together to generate better outcomes for the environment.

The need for government intervention also relates to commodities where it is difficult to distinguish between the end products of individual firms. A kilowatt-hour of electricity or a ton of steel is the same whether it is produced in an old dirty factory or a new clean one. The situation is different for products that can be tailored to meet precise market niches and where the manufacturer can compete on the perceived value of the unique product. Here, the producer competes on far more than price; brand name reputation, and quality may be more important to the consumer than the cost of the product. Buyers for these "tailored" products are more willing to pay a premium for green products that are environmentally friendly. Producers that continue to use older technology may continue to sell on low price alone but are doomed in the end by market forces. In such cases, government intervention to shut down older polluting factories may be less necessary.

Eco-Labeling and Certification

There are many "green" products on the market, but consumers are sometimes confused by their claims and have doubts about their validity. Eco-labels can be a useful tool to provide information about the environmental standards of a product. There are many eco-labeling schemes in use around the world ranging from those for paints and pesticides to paper products, household appliances, and construction materials. Manufacturers can be encouraged to produce eco-products due to the economic benefits in marketing them, and eco-labeling can in turn serve as a good policy tool to raise the overall international competitiveness of international companies.

Green label schemes have been widely used since the 1970s. There are currently about 50 different ones most of which are run on a voluntary basis. Germany's "Blue Angel" label, the first national scheme in the world, was introduced in 1977 and has awarded over 4,000 labels to a wide range of products. Surveys show that 79% of German consumers recognize the "Blue Angel" and generally perceive it as a reliable indicator.[243]

Table 4: Eco-Labels in Asia and the Pacific

Country	Organization	Eco-Label	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[244]
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[245]
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 - As of June 1997, the program has issued 2,031 awards in 69 product categories[246]
Republic of Korea	Korea Environmental Labelling Association, Korean Ministry of Environment	Environmental Labelling Program(Eco Mark)	- Launched in June 1992 - 2,041 certified products (506 companies) in over 100 product categories[247]
Malaysia	Product Certification Program	SIRIM** Quality Assurance Services	- Launched in 1996
New Zealand	Environmental Choice New Zealand	Environmental Choice New Zealand	- Over 200 products in 29 product categories[248]
PRC	China Certification Committee for Environmental Labeling Products*	Ten-Ring Mark	- Established in May 1994 - As of May 2003, 527 PRC enterprises, and a total of 3,426 products, had been certified[249]
Singapore	Singapore Environment Council	Singapore Green Labelling Scheme	- Launched in May 1982 - About 300 products in 32 categories[250]
Taipei,China	Environment and Development Foundation	Green Mark Program	- Launched in August 1992 - Nearly 1,400 products certified in 87 product categories[251]
Thailand	Thailand Environment Institute	Green Label Program	- Launched in August 1994 - About 144 products (and 29 companies) in 16 categories[252]

* Third-party certification program under the direction of the China State Bureau of Technology Supervision (CSBTS) and the National Environmental Protection Agency
** Standards and Industrial Research Institute of Malaysia

Others include the US Green Seal Program, the EU's Eco-label, the Nordic Swan, and the Canadian Environmental Choice.

More than 10 Asian countries now have eco-labeling schemes, and the approach is gaining public recognition and acceptance (see Table 4), but the implementation of such schemes has faced a number of challenges. Some have been seen as distorting the market and the conditions for fair competition, especially in product groups

where national and foreign producers directly compete. Another constraint has been the reliable verification of the environmental features of a labeled product.

The success of national eco-labels varies widely from country to country. An assessment of eco-labeling schemes in Asia and the Pacific made by USEPA in 1997 showed the mixed success in the region. For example, the study found the following.

- In Japan, the Eco Mark label is well known. In 1993, 53% of the public and almost all local governments were aware of the program. More than half of the companies who had acquired the logo did so to improve their corporate image, citing also "requests from customers and increased sales."
- In Taipei,China, the effectiveness of the Green Mark logo was unclear. Among licensees surveyed, nearly 80% reported that the logo is helpful for their companies and 72% said it is helpful for promoting business. However, critics wanted more product categories added and were unsatisfied with the logo's low visibility among consumers. A 1996 survey showed that only 40% of the general public recognized the logo, and only 30% reported having bought labeled products.
- In India, only one product in the detergent product category had been awarded the Ecomark, and the manufacturer of that product did not even market the product with the ecolabel. The failure of industries to get certified was attributed to the application costs and the numerous regulatory requirements required of manufacturers.

In recent years, eco-labeling organizations in the region have taken a number of steps to improve their labels. First, most of them have opted to comply with ISO. These standards establish three types of labels as summarized Table 5. As is the case worldwide, most organizations from the region have pursued a type I label. This requires an assessment based on some life-cycle considerations but not the rigorous use of lifecycle environmental information. The Republic of Korea briefly experimented with the latter approach but found that the significant data requirements of the LCA approach were difficult to meet. Its Eco Mark approach to product certification is, therefore, based on defining the single most important environmental impact for each product category.

Another recent development is that most, if not all, the eco-labeling organizations in the region have joined the Global Eco-Labeling Network (GEN), a nonprofit association of environmental labeling organizations around the world. Organizations from the region have sought out membership in GEN to exchange information and to receive assistance on how to improve, promote, and develop their labeling products.

In addition, there is a growing movement to harmonize environmental labeling programs within the region, again with help from GEN. 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 product-by-product basis such as the common core criteria for paints or for toner cartridges. It is fully expected that certification standards will, however, be unified step-by-step from the national to the regional and eventually to the international level.[253] While this will take some years, harmonization could one day help make eco-labeling a powerful global tool to encourage sustainable consumption.

Another important milestone is the strong relationship that many of the eco-labeling organizations have formed with procurement programs. For example, the central government in Japan 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.

Most importantly, these schemes are receiving greater attention by consumers.

Table 5: Label Types Established Under ISO 14020

Label Elements	Type I	Type II	Type III
Typical product attributes and criteria	Multiple attributes	Single attributes	Multiple attributes
Third-party involvement	Yes	No	Yes
Rigorous open consultation	No	No	Yes
Life cycle information	Yes	No	Yes
Quantitative life cycle information communicated to foster comparison of products	No	No	Yes
Potential for standardization	Low	Low	High

In Singapore, for instance, the demand for products endorsed under their eco-label program has increased significantly in recent years. By continually reaching out to the public and adding new products to labeling schemes, these programs in the region have the potential to eventually influence and cover the development, import, and wholesale marketing of "green products" that could encompass a majority of the local market.

In addition to these national eco-labeling schemes, there are a number of product-based certification systems that may become influential mechanisms for encouraging sound environmental management in the region. Examples include systems covering forest and fish products as well as tourism services.

Forest products: In the forestry sector, the World Wide Fund for Nature (WWF) was instrumental in the creation of the Forest Stewardship Council (FSC)—a labeling system designed to encourage consumers to buy products only from forests that are managed sustainably. This environmental initiative quickly spurred the emergence of a number of competing or complementary certification systems. While there has been some customer confusion over competing systems and a failure of "mutual recognition," these forest certification systems are believed to have led to a significant improvement in forest management in the developed world.

However, forest certification has its critics, many of whom charge that it takes place where forest management is already reasonably good and ignores those areas where forest management is poor or nonexistent. This contention is supported by the fact that developed countries have captured the lion's share of the certified wood market, while only about 18% of the world's certified timber and timber products originate from developing countries. Countries in the region have thus far been able to gain access to only a meager 3% of this market. The conundrum for developing countries is that certification systems cannot help improve forestry practices when there is a lack of institutional infrastructure in place to facilitate the inspection of harvesting practices.

Furthermore, many developing countries feel that the criteria and standards set by internationally recognized certification bodies such as FSC are too stringent and will thus lead to large increases in production costs. One study estimated that compliance costs range between 10–20% of average tropical log prices for developing countries.[254] Also, the market benefits look uncertain and distant to many timber producers in the region as the price premium received would need to exceed these

increased costs to create an economic incentive for a logging firm to comply with the standards. For these reasons and despite the obvious uncounted costs of timber production from biodiversity loss, watershed damage, etc., many countries in the region perceive certification as a nontariff barrier on a commodity where they otherwise have a comparative advantage. Some governments also question the legitimacy of international certification bodies to make judgments that have such huge impacts on trade and economic growth in their forestry sectors.

Despite these objections, most developing countries are gradually striving towards sustainable forestry management, and some are still working towards securing FSC endorsed certifications. However, countries such as Indonesia, Malaysia, and Papua New Guinea have opted instead to develop national certification authorities and schemes that are intended to be compatible with international certification requirements while also ensuring that certification criteria consider local situations.[255] Unfortunately, the FSC and many environmental NGOs are reluctant to recognize these national schemes on the grounds that they could lead to a lowering of standards that will simply legitimize the status quo that allows enormous uncompensated damages to occur as a result of poor and unsustainable logging practices. Some claim that this was precisely the case with the new national certification scheme in Indonesia (Lembaga Ekolabel Indonesia).

Until these problems are resolved, developing countries in Asia and the Pacific are unlikely to see significant increases in their timber exports to developed countries based on any notion of those products being sustainably produced. This comes at a time when many countries in the region, motivated by the prospect of foreign exchange earnings, are boosting timber production and export through greater reliance on plantation forests rather than the past practice of clear cutting vast tracts of natural forest. For example, the PRC is already well along in its program to establish 9.7 million hectares of plantations between 1996 and 2010, while the Philippines and Viet Nam are planning an additional 2.5 and 5 million hectares of plantation forests respectively over the next 10 years. Unfortunately, the replacement of biodiverse natural forests with plantation monocultures results in an enormous and often irreversible loss of unique habitats, and forest certification probably will remain a weak tool for curbing the illegal and/or unsustainable logging that remains a problem in many tropical forests.

Fish products: Unilever and WWF cooperated in creating the Marine Stewardship Council (MSC) as a labeling system designed to encourage consumers to buy fish products that avoid unacceptable fishing practices—notably the unsustainable overharvesting of natural fish stocks. Approved traders can label their products as having been sustainably caught.

While the scheme holds some promise, it also has experienced its share of problems and the program is still small—only 0.7% of the world's fisheries have been granted the label—so it is not yet a powerful force in the market. In addition, it has recently been attacked by environmental groups for allegedly not policing its eco-label properly. It was found that certificates were given to fisheries that had yet to meet certain basic standards and that no applications had ever been turned down or revoked. Furthermore, sanctions are unclear for producers who do not meet the standards.[256]

Still, if MSC addresses these problems, it could be a positive force for change in Asia and the Pacific. MSC has recently reported an increase in the number of fisheries seeking its assessment in the region and has specifically targeted the Asian and Pacific market because it is the largest seafood producing and consuming region in the world. MSC staff have attended meetings and spoken at conferences/workshops in Hong Kong, China: Indonesia; Japan; Republic of Korea; Malaysia; Thailand and Viet Nam to gain an increased understanding of the complexities, expectations, and opportunities within this region.[257]

Eco-tourism: Another certification scheme still in its infancy is the Sustainable Tourism Stewardship Council. In 2002, the Rainforest Alliance Sustainable Tourism Division concluded an 18-month feasibility study to investigate the possibility for establishing this international accrediting body to promote integration of sustainability into tourism policies and higher environmental and social standards for tourism. Since then, the main focus has been on launching the Sustainable Tourism Certification Network of the Americas. However, the campaign is intended to be international and will thus likely become more active with the Asian tourism industry. The international effort is led the Rainforest Alliance, the World Tourism Organization, the International Ecotourism Society and UNEP.

A challenge for the tourism council is to unify standards from a number of ecotourism certification organizations. In Asia and the Pacific, this includes the Green Leaf program in Thailand that was established in 1998 by the Board of Environmental Promotion for Tourism Activities. This scheme was initially created to certify hotels according to their efficiency in managing energy, environment, and natural resources but was intended to become a broader certification body for the entire tourism industry in the country.

Such labeling schemes create both opportunities and problems for producers in Asia and the Pacific. On the positive side, they create a chance for the region's companies to capture market share away from those who do not meet best industry practice. On the negative side, actual and demonstrated compliance may impose new bureaucratic costs on producers in the region. Furthermore, while some consumers express a desire for certified products, especially those with recognizable eco-labels, there is only limited evidence that these consumers are willing to pay much of a premium for these products. Quite often, the new systems demand independent third-party verification, and this is another new cost on business. Nonetheless, labeling and certification systems clearly are catching on in the region and are likely to increase their influence over time, especially as more affluent customers, both in OECD markets and the countries of Asia and the Pacific, demand more information and more quality in the products they buy.

Payment for Ecosystem Services

Natural ecosystems provide valuable environmental services which unfortunately are often viewed as public goods and as such are often taken for granted until degradation such as deforestation results in floods, loss of water quality, or threatened livelihoods. A new approach called "payments for environmental (or ecosystem) services" (PES) attempts to address this problem. The core of PES schemes is that those who pay should be aware that they do so to secure the provision of a valuable environmental service, and those who receive the payment are paid to engage in meaningful and measurable activities to secure the supply of those environmental services.[258] As major beneficiaries of ecosystem services, the private sector can and should play a critical role in expanding the concept of PES.

At present, there are three main markets emerging for ecosystem services:
(i) watershed management which may include control of flood, erosion, sedimentation, and water quality as well as maintenance of aquatic habitats and of dry season flows;
(ii) biodiversity protection which includes eco-labeled products, ecotourism, and payments for conservation of wildlife habitat; and
(iii) carbon sequestration wherein international buyers pay for planting new trees or protecting existing ones to absorb carbon, thereby offsetting carbon emissions elsewhere.

Various groups are involved in a PES scheme. Sellers include private landowners and communities while buyers are individuals, private companies, NGOs and even international organizations. A third and critical participant is the "broker" who minimizes transaction costs by matching buyers and sellers and facilitating negotiations. Brokers could include NGOs, individuals, and even specialized private companies. Governments have adopted various roles—from buyer to seller to broker—depending on the nature of the scheme.

PES schemes are meant to be win-win propositions from the perspective of both the buyer and seller of environmental services as well as from the point of view of society. The buyer is assured of a sustainable source of the environmental service, e.g., clean water, or is able to enjoy an environmental amenity, e.g., through ecotourism. The provider is compensated accordingly for instituting suitable practices (e.g., reforestation) to safeguard the environmental service. Society benefits as most of the environmental services constitute public goods and services—carbon sequestration and biodiversity conservation are services for the global community.

PES schemes have originated in developed countries, particularly in the US, through conservation and land trust programs and tax relief schemes. In the developing world, South American countries such as Costa Rica, Brazil, Ecuador, Mexico, and others have pioneered PES schemes covering a wide array of environmental services. By contrast, such initiatives in Asia and the Pacific are in their relative infancies. but with its rich natural resources, the region holds great potential for developing PES mechanisms and applications.

A good recent Asian example of PES may be found in Lao People's Democratic Republic (Lao PDR), which is entering a period of economic growth that will depend on effective management with one of its rain natural resources—river water. To ensure long-term sustainable development, the Lao PDR needs to harness its vast hydroelectric power potential in a socially and environmentally sustainable way. The Nam Theun 2 Hydroelectric Project is one such scheme, and part of the sustainability plan calls for careful attention to protecting the watershed that feeds the dam. As an innovative PES measure under the project, the privated sector associated with the hydropower generation will pay $31 million to maintain and enhance these watershed services. In so doing, the project will help preserve one of the Greater Mekong Subregion's few remaining intact tropical rainforests and wildlife habitats while at the same time providing an additional 200-300 6wh of electricity generating capacity to the market.

NEW ENVIRONMENTAL BUSINESS OPPORTUNITIES

The previous section focused on how firms can add to profitability and improve their environmental performance by focusing on cleaner production practices and energy efficiency by investing in new technology or by switching to production processes recognized as sustainable. This section discusses another way that "going green" can be profitable through the expanding market for environmental goods and services. First, we look at the definition of "environmental goods and services," the size of the global and Asian and Pacific markets, and the trading of these goods in these markets. Then we discuss in detail the significant opportunities that exist for the private sector to use its technological expertise to tap these opportunities and play a larger role in environmental management.

Definitions: It is useful to begin this discussion with a few words about the definition of the market. To date, there is no comprehensive, international definition of "environmental goods" or "environmental services" or any internationally agreed criteria for its classification. Where they exist at all, definitions and classifications differ from country to country. In 1999, an informal working group of national experts from OECD countries came up with what is now the most commonly used definition. With the main goal of improving the collection of consistent information on various economic aspects, they defined environmental goods and services as, "…activities which produce goods and services to measure, prevent, limit, minimize, or correct environmental damage to water, air, soil, as well as problems related to waste, noise, and ecosystems."[259] Any attempt to assess the business potential in this area will need to deal with such definitional problems.

The current focus of debate is placed on a "list-based" approach whereby countries submit their own registries of environmental goods. In this effort, lists that have been previously developed by the Asia Pacific Economic Cooperation (APEC) and OECD have served as reference points. There are some similarities in the APEC and OECD approaches as both share a common set of environmental functions for which they seek to define goods, and the two lists have 54 goods in common. However, 50 goods on the APEC list do not appear on the OECD list, while 68 goods on the OECD list do not appear on the APEC list.[260]

The market numbers presented in the next section come from a private firm that in 1996 mapped various activities in the global environmental market.[261] Environmental goods and services as assessed by a growing number of other organizations, including OECD and the United Nations Conference on Environment and Development (UNCTAD), have since become characterized by industry activities made up of the products, services, and technologies highlighted by the firm. Their analysis included 14 different types of goods and services in three categories as shown below.

- *Equipment:* water equipment and chemicals, air pollution control, instruments and information, waste management, process/prevention technology;
- *Services:* solid waste management, hazardous waste management, consulting and engineering, remediation and industrial, analytical services, water treatment services;
- *Resources:* water utilities, resource recovery, environmental energy.

It is important to note that the list of environmental goods and services from various sources includes items that are used for other purposes besides environmental protection. For instance, an analysis of APEC's list done by The Energy and Resources Institute of India found that only 16 out of 109 items could be predominantly used for environmental purposes. Much of the equipment mentioned is, to a large extent, used for other purposes. For instance, equipment such as fans and blowers and vacuum pumps may or may not have any use in environmental protection.[262]

Global Market for Environmental Goods and Services: One estimate of the global market for environmental goods and services based on the OECD definition is €550 billion ($500 billion in 2002 prices) per year worldwide. This includes cleaner technologies, products, and services that reduce environmental risk and minimize pollution and resource use.[263] The global market for environmental goods and services as estimated by the forementioned US research firm was about $US 552 billion in 2001. Based on the numbers and analysis of trends, ADB estimates the current global market to be about $607 billion and projects it to grow to over $836 billion by the year 2015 (see Table 6).

By category in 2001 (the latest year for which disaggregated data is available), $284.6 billion was in "services", $147.4 billion in "resources", and $120.4 billion in "equipment" (see Table 7). Although the relative importance of individual segments of the environment industry varies between countries, the most important investment area is for water and wastewater management, accounting for $209.3 billion or nearly 38% of the market. This is followed by (solid and hazardous) waste management at $173.8 billion for over 31% of the total. Other notable elements include: resource recovery ($36.6 billion), air pollution control ($35.3 billion), consulting and engineering ($31.4 billion), remediation services ($28.2 billion), and clean energy systems and power ($23.9 billion). The importance of water and wastewater management is even more pronounced in Asian developing countries where such demand comprises up to 50% of the market. Waste management is a distant second at 22.5%.

The majority of revenue from the environmental industry is still generated in the US, Western Europe, and Japan with shares, respectively, of 39%, 29%, and 17% in 2001 (see Table 6). These countries dominate the

Table 6: The Global Environmental Market (units in $US billions)

By Region	Actual						Forecasts	
	2000	2001	2002	2003	2004	2005	2010	2015
USA	210.5	215.2	221.4	227.5	233.7	240.2	275.1	315.0
Western Europe	157.8	160.8	165.0	169.1	173.4	177.7	201.0	227.5
Japan	93.7	93.3	92.4	92.6	92.9	93.1	94.4	95.6
Australia / NZ	8.4	8.6	8.8	9.1	9.5	9.8	11.7	14.0
Rest of Asia	24.0	25.6	28.16	31.0	34.1	37.5	66.1	116.4
Other Regions	47.6	48.5	45.4	46.6	47.8	49.1	57.0	67.6
Global	542.0	552.0	561.1	575.9	591.3	607.4	705.3	836.1

Source: Environmental Business International Inc. and ADB staff estimates

global environmental market due to the size of their domestic economies combined with the ability of their environmental companies to export to the developing world.[264] Domestic environmental industries in these countries are characterized by intense competition combined with increasing consumer sophistication, decelerating growth, and reduced profitability. Thus, many firms from developed countries are looking for new market opportunities primarily in the developing world and increasingly in Asia and the Pacific.

The global market has been growing at a modest rate of about 3% per annum (1996 to 2001). But while the market in developed countries experienced only 1% annual growth, in developing countries it grew at an annual rate of 7–8% during this same period. Most of the growth in the foreseeable future will take place in developing countries and economies in transition (at an estimated annual rate of 8–12%) as these countries continue to grapple with environmental problems associated with growing populations, increasing industrialization and urbanization, and the many market and social forces to improve environmental performance that are identified in this report.

Another characteristic of the environmental goods and services market is the predominance of small environmental firms—at least in the developed countries—with revenues of under $10 million. In the US, there are over 30,000 firms in the environmental goods and services category. New entrants particularly dominate the service sector due to the low cost of entry. This bodes well for entrepreneural activity—and employment generation—in Asia and the Pacific as this market expands.

The Asia and Pacific Market: The region's market is currently estimated to account for $37 billion of the global total but its growth rate is the fastest in the world, with the market expected to triple by 2015. However, this actually underestimates the size of the regional market, because there is likely to be a further tightening of environmental requirements that should result in an acceleration of growth in the environmental goods and services industry. Furthermore, many types of environmental infrastructure investment are not even included in these figures. Demand for all types of infrastructure investments in East Asia alone is already estimated ti be about $200 billion annually.

Table 7: Asia and Global Environmental Market (by Segment)

	Asia (2000)*		Global (2001)	
	$US Billions	Percentage	$US Billions	Percentage
Equipment				
Water Equipment and Chemicals	3.2	13.3	42.9	7.8
Air Pollution Control	3.0	12.5	35.3	6.4
Instruments and Information Systems	0.6	2.5	6.6	1.2
Waste Management Equipment	1.1	4.6	32.6	5.9
Process and Prevention Technology	0.3	1.3	3.0	0.5
Services				
Solid Waste Management	3.7	15.4	120.3	21.8
Hazardous Waste Management	0.6	2.5	20.9	3.8
Consulting and Engineering	0.9	3.8	31.4	5.7
Remediation/ Industrial Services	0.4	1.7	28.2	5.1
Analytical Services	0.3	1.3	4.3	0.8
Water Treatment Works	3.6	15	79.5	14.4
Resources				
Water Utilities	5.2	21.7	86.9	15.7
Resource Recovery	0.2	0.8	36.6	6.6
Clean Energy System and Power	0.8	3.3	23.9	4.3
TOTAL	**24**	**100**	**552**	**100**

*Excludes Japan, Australia, and New Zealand
Source: Environmental Business International Inc.

Among the region's developing countries, the PRC and India are the largest and would likely be the fastest growing markets. This growth is largely driven by rapidly expanding urban centers where an emerging educated and affluent middle class is increasingly demanding that their governments—national, state, and local—develop more and better environmental infrastructure. In response, a number of governments in Asia are beginning to mainstream environmental concerns within national policy-making agendas which means that environmental infrastructure is finally enjoying more importance in national planning.

The number of industries demanding pollution control is rapidly growing. In addition, most countries have implemented legislation to protect air, land, and water, and standards and regulations are moving forward on hazardous waste and vehicle emissions. More stringent enforcement of these pollution regulations combined with a wide range of other incentives described in this report are creating a huge new market for pollution control equipment and a range of services to accompany them and the softer EMS approaches of eco-efficiency improvements.

Meanwhile, some countries, such as Indonesia, Malaysia, Philippines, and Thailand are going forward with privatization and public-private collaborations on public utilities. Much of the initial driving force of market growth is multilateral and bilateral assistance, and governments are beginning to spend enormous resources on building and upgrading waste disposal and sewerage facilities, water supply and treatment systems, and solid waste management systems in major cities. The principal constraint is the scarcity of financing resources though new and innovative mechanisms are emerging here as well (see Chapter 7).

One of the most important changes to the structure of the industry has been the technological shift among polluting industries from traditional end-of-pipe solutions to cleaner technologies that reduce pollutants at the source. Given the amount of investment in pollution reduction in developed countries over the past 20 years, growth rates for traditional pollution abatement methods have declined to less than 2% per year.

In Asia and the Pacific, however, increased investments in cleaner technologies and retrofits will likely happen simultaneously. In the PRC and other countries, there is a significant need to upgrade the energy sector and other polluting industries. Because of this, pollution control investments registered a 16% growth rate in 2003 with double-digit rates anticipated into the first two decades of the 21st century.

Trade in Environmental Goods: With many firms in developed countries looking to export their products and with markets in developing countries rapidly expanding, the global environmental industry that was once not very export oriented has changed dramatically in recent years. This shift has been aided by a number of policy trends such as the harmonization of national environmental standards (especially in the EU), the implementation of multilateral environmental agreements, and the privatization of utilities in many countries. Now, half of the environmental goods and services market is supplied by exporters. From 1990–2002, the global export market for the combined OECD/APEC list of environmental goods and services was growing twice as fast as total merchandise trade reaching over $200 billion in 2002 (almost 4% of world exports). The fastest growing areas over this period have been solar energy photovoltaics (31%) and wind energy (25%).

Developed countries provide 79% of the exports of environmental goods with the US (at 20%), EU (at 15%), and Japan (at 14%) in the lead. Developing countries currently provide only about 21%. The environmental goods and services sector is also characterized by a high degree of market concentration.[265] The top 20 exporters of environmental goods accounted for about 93% of world exports while the top 20 importers comprised nearly 87% of world imports.

While developed countries currently dominate the market, Asian countries are the leaders in the developing world. The exports of environmental goods by the top developing countries in Asia made up 90% of the total developing country exports in 2000. These countries include PRC, India, Indonesia, Malaysia, and Thailand.[266] In addition, while developing countries rely on developed countries as their principal source of imports of environmental good, intraregional trade in Asia and the Pacific is also substantial and is likely to grow.

Some developing countries may be able to compete very well in subregional or regional markets where experience in similar environmental problems is shared. They also may have export potential in environment-related professional services such as environmental assessments, consultancy services, implementation and auditing of environmental management systems, evaluation and mitigation of environmental impact, and advice in the design and implementation of clean technologies. As the services side of the market expands, providers from Asia and the Pacific should have significant comparative advantage due to their lower labor costs.

Developing countries in the region also appear to have a strong position in the market for environmentally preferable products. Although the scale of such products ($28 billion) is smaller than that of the global market for environmental goods, products in this market have great export potential.[267]

Environmental Infrastructure

As noted, the educated and increasingly affluent middle classes emerging in Asia and the Pacific increasingly demand that governments, both national and local, provide new and better environmental infrastructure. There are constant demands for publicly owned wastewater treatment facilities to collect and treat contaminated municipal waste and discharge clean water back into water bodies. Once governments and societies in the region make this commitment, there will be hugely increased demand for architectural, engineering, and design services; construction contractors; and building material suppliers.

Let us take water and sanitation as an example. According to a new ADB report, as of 2002, approximately 685 million people in the region were still without access to safe drinking water with nearly half of them in North and Northeast Asia, especially the PRC. This represents the majority of the estimated 1.1 billion people globally without adequate water supplies. Also as of 2002, nearly 2 billion people from the region were without access to improved sanitation facilities out of a total of 2.6 billion for the world as a whole. The cost of halving the proportion of people without sustainable access to both improved water supply and improved sanitation (that is, achieving the water and sanitation MDG targets) would cost around $8 billion annually up until 2015. To provide access to improved water and sanitation services to all the unserved people of Asia and the Pacific would cost around twice as much, i.e., $16 billion per year until 2016. The cost of providing household water treatment using chlorine and safe storage in addition to improved water and sanitation services for all would cost an additional $1 billion on top of improved water and sanitation costs taking the global cost to $17 billion. Providing access to a regulated, in-house piped water supply with quality monitoring and an in-house sewage connection with partial treatment of sewage for all households would require a total investment of $85 billion per year.

As half the population of Asia and the Pacific will be living in cities within the next few decades, there will be about 400 million households. With an average capital cost for a household connection for water and sanitation at $100, the total market for connecting half the households alone is about $20 billion. Using an average consumption of 100 liters of water per capita per day and average tariffs of around $0.20 per cubic meter, revenue from those 200 million households could be about $36 billion per year.

Much of this growth will be experienced in the PRC. According to its Tenth Five-Year Plan, the PRC's municipal wastewater treatment rate needs to increase to 60% in 2005. Although this target probably will not be met, the Eleventh Five-Year Plan has similarly ambitious targets. In response, new municipal wastewater treatment plants are rapidly being constructed. According to a recent report by the US Department of Commerce, four new projects alone[268] will account for an anticipated total investment in the PRC of approximately $22 billion

in water supply and wastewater treatment facilities before 2013.[269] This will create many opportunities for both foreign enterprises and the growing domestic environmental industry as the operation and maintenance of all existing and newly built municipal water and wastewater treatment plants is transferred to authorized enterprises.

The increase in the number of wastewater systems in the PRC and other countries will drive the demand for a wide range of environmental equipment. Water pollution control includes physical, chemical, and biological processes; membrane technology; sludge and odor management; and process instrumentation and control. Some market forecasts for specific products are presented below.

- Municipal wastewater plants are expected to emerge as the largest single purchasers of industrial pumps that move sewage to treatment plants, through treatment, and finally to move clean water back to the waterway. Global sales of these pumps will reach $6.8 billion in 2007, and the PRC is the fastest growing market.[270]
- Asia and the Pacific also will be the fastest growing region for the sale of sedimentation equipment and centrifuges. In response, a number of European and US suppliers of this equipment have set up operations in the PRC. The region's purchases in the wastewater sector alone should rise from $400 million this year to just under $500 million in 2007.[271]
- The municipal water and municipal wastewater segments are also the largest purchasers of macro liquid filtration equipment and media, the global market for which is estimated to be $4 billion in 2005. By 2006, the PRC is expected to become the world's largest consumer of granular media filters that purify drinking water, worth some $220 million. A further $100 million of filter presses that separate chemical products from slurries and are commonly used in the chemical industry, also are expected to be purchased by the PRC.[272]

The shortage of clean water and improving technology should also open up a new market for desalinization plants. With the continuing reduction in the operating cost of reverse osmosis systems and the rising cost of procurement and treatment of surface water, desalinization plants are looking more and more attractive, especially in the PRC. The country might follow the lead of California where a growing portion of water supplies are derived from this technology. The poor quality of drinking water is also driving sales of bottled water, and this is creating a substantial market for reverse osmosis at bottling plants.[273]

Renewable Energy

The International Energy Agency estimates that cumulative investment in renewable 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 the equivalent of 1,400 metric tons of oil in 2002 to 2,200 in 2030. Despite this significant increase, renewable energy consumption as a percentage of overall energy consumption is expected to remain stable at around 14%.

Many countries in Asia and the Pacific are increasingly looking at renewable sources to meet their energy needs (see Table 8). In the PRC for instance, starting from a base close to zero, renewable sources are predicted to increase by a nevertheless remarkable factor of 41. With the growing awareness of the importance of renewable energy sources and their potential role in decentralized energy generation, the rate of growth is expected to accelerate. The pace of commercialization of these technologies is also expected to grow due to rising global concerns over climate change and associated developments, such as the clean development mechanism that will allow renewable energy projects executed in developing countries to generate revenues though certified reductions in emissions.

However, renewable energy technologies still face a number of barriers in the region including subsidies for fossil fuels. To a large extent, investment decisions will depend on the effectiveness of government measures to promote renewable energy technology. The private sector is unlikely to invest in costly renewable energy systems without 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.

Research and development efforts in most of the region's developing countries have not yet achieved many large-scale successes. The relative success of the large countries such as the PRC and India appear to suggest that resource constraints have hindered these efforts in the smaller countries. To address this problem, regional networks could be useful. Late in 2004, six countries along the Mekong River—Cambodia, PRC, Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam—agreed to promote the use of alternative energy, including hydro-electricity, ethanol, and bio-diesel. This covers the production and use of ethanol and bio-diesel to help reduce pollution. The participants also agreed to boost the supply of electricity to remote areas in the region. The six plan to exchange power across their borders where possible.[274]

The demand for alternative energy projects arises from two main concerns: universal access to rural electrification and environmental protection. Each of these is discussed separately below. Another factor is the increasing price of fossil fuels. Increased demand for fossil fuels has created upward pressure on most energy costs and prices worldwide. While not good news for consumers, higher fossil fuel prices make renewable energy more attractive and the higher capital costs more justifiable.

Renewable energy and electricity generation: Worldwide, renewable energy for generating electricity will double between 2002 and 2030, accounting for 18% of electricity in 2002 and 19% by 2030. The small percentage increase is due to the rapid expansion of fossil fuels, primarily coal, and nuclear power.

With millions of households in Asia and the Pacific lacking electricity, there is a great deal of demand for decentralized systems that use renewable sources of energy. At present, there are 798 million people in South Asia (Bangladesh, India, and Pakistan) without electricity. This number is forecast to decline to 683 million by 2030. In East Asia (the PRC and all of Southeast Asia), the comparable numbers are 221 million in 2002 and 98 million in 2030. The majority of these people are the rural poor who need low-cost energy to work themselves out of poverty but who are the furthest away from national grids and cannot afford high-tech, renewable options.

While access to modern energy is secondary to the more basic issues of survival, many Asian governments are supporting efforts to provide electricity service to households in remote rural areas where low load densities make the costs of conventional grid extension uneconomical. Local renewable energy resources can be used to supply electricity to these areas using individual systems or independent grids. The most common are photovoltaic systems and isolated hydropower.

Renewable energy and environmental protection: Even though most nations in Asia and the Pacific are not currently required to reduce GHGs under the Kyoto Protocol, in the future carbon dioxide emission limitations will affect them since they will rank among the world's largest contributors to global warming.[275] As a result, every nation in the region will not only need to integrate pollution-control technology into the core design and operation of coal-fired power plants and industrial boilers (see previous section) but will also need to find alternatives for large-scale power generation. These alternatives will include solar, fuel cells, wind, wave, hydro, nuclear, biomass, combined heat and power applications, and various systems that use coal more cleanly, e.g., fluidized bed systems and gasification or liquefaction.

This motivation is especially critical in the larger and more industrialized countries such as the PRC and India. In these countries, coal or fossil fuel–fired electricity generation is the fastest-growing component of energy supply as residential and commercial electricity demand grows and as industries switch to the convenience of electricity. The high projected growth rates for energy demand present a significant opportunity to displace fossil fuel resources with alternative energy and reduce the emissions of damaging carbon dioxide, sulfur dioxide, nitrogen dioxide, and particulates.

Even small-scale rural systems have environmental benefits. First, greenhouse gases are reduced by replacing gasoline and diesel (for generators), kerosene (for lamps) and other fuels that would otherwise be used for lighting. At present, most of these communities depend on diesel generators for limited and intermittent electrical service. Diesel fuel is expensive, delivery of the fuel is unpredictable, and diesel generators are a significant source of primary GHGs and carbon dioxide as well as other conventional pollutants. Second, an expanded use of certain key technologies such as household-scale solar photovoltaic systems is expected to reduce the costs so that the technology will be used in larger-scale applications where the GHG mitigation potential is much greater.[276]

Environmentally Responsible Procurement/Environmentally Preferable Products

Green procurement means selecting environmentally preferable products (EPPs) defined by UNCTAD as, "…products which cause significantly less environmental harm at some stage of their life cycle (production/processing, consumption, waste disposal) than alternative products that serve the same purpose, or products the production and sale of which contribute significantly to the preservation of the environment of products and services that minimize environmental impacts." Narrowing the classification of EPPs in WTO negotiations will one day give the market for these products a huge boost, but such a classification is still a future goal. For starters, it is difficult to prove the "environmental friendliness" of products even using LCA tools. Nevertheless, a number of distinct types of EPPs can be identified based on their environmental justification or benefit. Some of these are as follow.

- Renewable/clean energy technologies: As discussed in the next section, there are clear environmental benefits as well as significant export potential for certain Asian countries in this sector. Based on the products listed in the OECD and APEC lists, a number of countries in Asia—Malaysia, Philippines and Thailand— had a small trade surplus in 2000. Products in this category could include zero emission and hybrid automobiles, bio-fuels, and renewable electricity generated by solar and wind technologies.
- Energy-efficient products: These products have substantial environmental benefits. Given that household electrical appliances (e.g., water heaters, air conditioners, personal computers) account for more than one quarter of total residential energy consumption, the increased use of energy efficient products would help limit emissions associated with electricity generation. Such products include energy efficient dishwashers, washing machines, household water heaters, and a wide range of electrical appliances (especially energy-efficient lighting and office machines).
- Products produced in an environment-friendly way: These include organic agricultural products and certified timber. The challenge with these products is the difficulties that arise in certifying them to an acceptable and uniform standard.

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Table 8: Renewable Energy Markets

Renewable Sources	Market Potential	Electricity Generation	Country Example
Wind	The market for utility scale wind turbines reached $6 billion in 2001 and is continuing to grow dramatically worldwide.[277] Many Asian countries are just now taking advantage of the many benefits of wind power and are thus far behind wind power leaders like Germany and Spain which are obliged under the Kyoto treaty to cut emissions of greenhouse gases. The projects developed so far are small in scale, but the region holds great promise.	Large wind turbines offer one of the most promising options for countries looking for renewable bulk power sources. The costs of installed generating capacity now rival those of the lowest-cost fossil-fueled power plants, and the scale has grown to as much as hundreds of megawatts (MW) per wind farm. There are serious proposals for offshore installations that will exceed 1,000 MW-capacity.[278] Wind power is also a good option for supplying power to remote areas as small wind turbines are able to operate satisfactorily at lower wind speeds.	The largest wind farm in Southeast Asia was just inaugurated in the Philippines at Bangui Bay in the northern province of Ilocos Norte. The wind farm, which is also the first in the Philippines, will harness strong sea winds with 15 towers and will have a total installed capacity of 24.75 megawatts. This project is the first step in tapping the Philippines' vast wind potential. Through the first contracting round held in 2005 and a second to come later this year, the Philippine Department of Energy is following through on their plans to offer 34 wind power sites for development across the country. Many of these planned wind farms will offer more capacity than the one just constructed.[279]
Small Hydro	Hydro will increase by over 60% with most of this growth in developing countries since most of the best sites in OECD countries have already been used. The PRC will have more installed hydropower than any country in the world by 2030. Governments, international banks, and large utilities have tended to focus their attention on larger scale hydro projects for a host of legitimate reasons.	Small hydro is already one of three renewable technologies (the others are biomass combustion and large wind turbines) that provide tens of gigawatts of electrical generation capacity worldwide.[280] Eco-friendly, small-scale hydroelectric power generation-less than 2 MW-holds great potential for many rural areas not connected to national electrical grid systems. These small turbines are also increasingly being used in cities where they can run facilities such as office buildings while feeding excess power back to the grid.	In rural Myanmar and other parts of Southeast Asia, there are a large number of small earthen reservoirs where excess rainwater is collected for irrigation for local farmers. Small-scale hydro turbines could be installed in many of these reservoirs and used to generate electricity for local farmers. As an added benefit, the water discharged to generate electricity can be reused for irrigation.

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Table 8 continued

Renewable Sources	Market Potential	Electricity Generation	Country Example
Commercial Biomass	While initial attempts to commercialize biomass largely failed, there are now a number of promising technologies for large-scale combustion. Much of the worldwide increase is likely to come from industrial combined power and heat installations, especially in the developed countries of Europe where government policy is a key driver. Commercial biomass may be used in co-firing with coal to reduce carbon dioxide emissions thereby contributing to meeting Kyoto targets.[281]	In 2000, the global installed capacity of electricity generation from biomass was about 40,000 MW. Many Asian countries are showing growing interest in electricity generation from biomass. By 2015, the PRC will have between 3,500 and 4,100 MW of biomass-based capacity and India will have 1,400 to 1,700 MW. An interesting new development is the use of gasifiers for small-scale village use. These gasifiers, which use agricultural and forest residues, can supply about 100 households with power for cooking and heating. So far they have been demonstrated in Indonesia, the Philippines, Sri Lanka, and Thailand.[282]	• India has launched the world's largest sugar-mill based cogeneration program. So far, a capacity of 358 MW has been commissioned, and another 389 MW is under installation. • Fixed-bed gasifiers are commercially available in the PRC and India. The total installed capacity of fixed bed gasifiers in India is about 35 MW. • Biogas production from animal wastes is well established in the PRC and India. In the PRC, there were about 6.8 million household digesters and more than 1000 medium and large-scale biogas plants for treatment of distillery and animal wastes at the end of 1997. In India, the number of household biogas digesters was about 3.1 million. • Research on the use of bio-diesel for running engines is in progress in a number of Asian countries, including India, Malaysia, Nepal, and Thailand.[283]
Waste to Energy	In contrast with many other energy technologies that require fuel to be purchased, these facilities are paid by the fuel suppliers to take the fuel (known as a "tipping fee"). The tipping fee is comparable to the fee charged to dispose of garbage at a landfill.	Municipal solid waste can be directly combusted in waste-to-energy facilities as a fuel with minimal processing known as mass burn. Waste can undergo moderate to extensive processing before being directly combusted as refuse-derived fuel, or it can be gasified using pyrolysis or thermal gasification techniques. Each of these technologies presents the opportunity for both electricity production as well as an alternative to landfilling or composting.	Japanese companies are now beginning to build waste-to-energy 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 fifty billion RMB to construct municipal garbage treatment plants, half of which will be spent on incineration plants.[284]

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Table 8 continued

Renewable Sources	Market Potential	Electricity Generation	Country Example
Solar	Worldwide, decreasing photovoltaic prices, combined with incentive and subsidy programs and renewable energy capacity mandates, have led to the emergence of a steadily growing market for bulk photovoltaic installations (greater than 100 kilowatt capacity).[285] The trend in Asia, however, has been to smaller, off-grid solar systems as a feasible alternative for electrification in rural areas.	Perhaps the most obvious application is passive solar to heat water. Solar energy to heat water is expected to increase from the equivalent of 4 metric tons of oil in 2002 to approximately 35 in 2030, almost a ninefold increase. Photovoltaic systems are now being proposed in many countries around Asia, and the successful experience in Sri Lanka and elsewhere shows a high willingness to pay for such systems. A recent study by the World Bank concluded that solar home systems provide high economic returns for areas with low load density for which grid extension is uneconomic. Still, small-scale systems are currently thriving where governments have set up innovative incentive schemes.[286]	In Asia and the Pacific, Sri Lanka has been most successful in promoting photovoltaic systems in rural areas. Since Shell Renewables Lanka Limited was formed in 1999 and started selling solar-power units to rural households, demand has been substantial. As part of a scheme to meet the micro-level requirements of rural households, Sri Lanka's few solar power companies joined the World Bank to subsidize solar units. Funds are disbursed to a local NGO that handles the financing and loan collection under the project. Once the units are installed, the NGO pays the solar companies and collects the money from users. Solar users make a small down payment and then pay once every 6 months for an average 5-year loan. Due to the success of the arrangement—there have been few defaulters among the farmers so far—Shell is considering it as a model for similar projects in India, Indonesia, and the Philippines.[287]
Geothermal	Although many countries in Asia have engaged in geothermal resource development, its capacity is not yet significant. The potential is greatest on the western Pacific Rim, or along "The Ring of Fire." Industrial focus so far has been on developing base-load generating stations of up to 1,000MW capacity for continuous operation.	Two developing countries located along this highly volcanic zone—Indonesia and the Philippines—have actively developed geothermal power; it accounts for 4% and 16% of the respective electricity supply for these countries.[288] One interesting application of geothermal power is to supply power to communities. As geothermal units as small as 100 kilowatts are feasible, the technology is suitable for small as well as large power grid systems. Additional benefits exist in developing a site where there is an industrial requirement for steam, which can cost as low as US$3.5 per ton as a byproduct of geothermal electricity generation.[289]	In the Philippines, geothermal electricity generation reached 1,909MW which ranked it second in the world behind only the USA. The Philippines' total potential is estimated to be between 2,300MW and 3,700MW. Meanwhile, Indonesia and Japan generate over 500MW of electric power from geothermal sources. These three volcanic archipelagos possess hundreds of prospective geothermal reservoirs. In contrast, countries in continental Eastern Asia show limited geothermal potential because they are distant from the Pacific subduction zone.[290]

Box 7: Adopting Green Procurement Practices

Practicing green procurement demonstrates commitment to considering and minimizing the environmental consequences of development activities. It should make both environmental and economic sense. Businesses often require a green procurement program as part of an EMS, as certified under the European Eco-Management and Audit Scheme (EMAS) or ISO 14001 regimes.

New government regulations in Japan and the Republic of Korea require the adoption of green procurement practices. Since 2001, Japan has implemented a Law concerning the Promotion of Procurement of Eco-friendly Goods and Services by the State and Other Entities. The objective of the law is to (i) encourage government agencies to procure eco-friendly goods and services, to provide information, and encourage a shift in demand toward eco-friendly goods and services; (ii) establish a sustainable society; and (iii) contribute to a sound and cultural lifestyle. Eco-friendly goods and services are defined in the law as (i) recycled resources, (ii) products contributing to the reduction of environmental impact, and (iii) services that contribute to the reduction of environmental impacts. 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. A 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. The Republic of Korea introduced similar mandatory green procurement for 20,000 public institutions, starting in June 2005. These will serve as models for other countries in Asia and the Pacific.

The European Commission has prepared a useful handbook on green procurement and co-funded research on the potential environmental benefits should green procurement be widely adopted in the EU. The findings suggest that (i) "green" electricity procurement by public agencies would save 60 million tons of carbon dioxide per year, equivalent to 18% of the EU's commitment under the Kyoto Protocol; (ii) more energy-efficient computers would save 830,000 tons per year of carbon dioxide; and (iii) efficient toilets and taps in public buildings would reduce water consumption by 200 million tons per year (equivalent to 0.6% of total household consumption in the EU). A database also has been established by the European Commission providing environmental information on about 100 products and also lists services groups catering to the green procurement market.

Sources: *EPA Guidance on Environmentally Preferable Purchasing and Pollution Prevention.* Regional Information Center. http://www.p2ric.com; European Commission. 2004. *Buying Green! A Handbook on Environmental Public Procurement.* http://europa.eu.int/comm/environment/gpp/pdf/int.pdf

- Products with environmentally friendly end-use and disposal characteristics: These include CFC-free refrigerants and biodegradable natural fibers used for packaging.
- Products that enhance the value of natural resources: Yet another group comprises products that contribute to the preservation of the environment. This includes those that enhance the value of tropical forests such as non-timber forest products (e.g. rattan and bamboo). Another item that falls into this category is eco-tourism.

There is a clear opportunity for entrepreneurs in developing Asia and the Pacific to further explore EPPs and even to expand the scope beyond those listed on the OECD and APEC lists. With government support, a number of issues also will need to be addressed that can affect trade in EPPs including the use of eco-labels that are seen by some as a type of non-tariff barrier. Other issues include non-tariff measures such as registration requirements and health requirements.

Environmentally Sound Primary Production

In the struggle to achieve sustainable development, arguably no sector is more important than food. The Green Revolution staved off the Malthusian threat of starvation in Asia and the Pacific, but it was not sustainable and yields have leveled off.[291] High levels of fertilizer and pesticide use create environmental problems and depend heavily on the continued availability of cheap fossil fuels.[292] Looking to the future, two alternative paths appear to be opening up—biotechnology (see Chapter 6) and sustainable (or alternative) agriculture. Environmentally sound primary production also addresses issues related to forestry and fisheries.

In the agriculture sector, sustainability is not just about increasing yields as many proponents of the biotechnology industry claim, it is also about food security and access to food by the world's poorest people. High yields from expensive hybrid or genetically modified seeds do not help poor communities that grow only enough food for self-sufficiency and cannot afford to buy the seeds. Sustainability also means using existing agricultural land over the long term to satisfy the region's food needs; it is not sustainable to destroy the soil through intensive agriculture, and then open up new forest areas for agriculture. In the forestry sector, sustainability means living within the annual increments of forest growth and ensuring that for every tree cut down, at least one is replaced. In the fisheries sector, sustainability means extracting only the sustainable yields of fish stocks and ensuring that land-based pollution and other activities do not destroy coastal and marine habitats.

It is useful, therefore, to think of sustainability at different hierarchical levels. For example, agronomic sustainability refers to the ability of a land plot to maintain productivity over a long period of time. Microeconomic sustainability relates to the ability of the farm to remain viable as the basic economic unit and to stay in business. Ecological sustainability depends on the maintenance of life-support systems provided by nonagricultural and nonindustrial segments of a region. Macroeconomic sustainability is controlled by factors such as fiscal policies, subsidies, and interest rates that determine the viability of national agriculture systems.[293] At the global level, there is something wrong with a food production system that leaves nearly 700 million hungry and malnourished and 300 million obese from overeating the wrong kinds of food. Constraints at each level—the field, farm, or watershed—nationally or globally can impede the adoption of sustainable agriculture.

Humans have been farming for over 600 generations, yet it is only in the past few that food production has been treated as an efficient "industrial" process rather than as part of a culture. Furthermore, it only appears to be efficient if we focus on the production outcomes rather than the side effects of soil degradation, biodiversity loss, eutrophication of waterways, and harm to human health.[294] Sustainable agriculture, therefore, involves reconnecting humans to their immediate environments and working closely with nature.

A survey of 208 projects in 52 developing countries involving 9 million farmers adopting low-cost, locally available, and environmentally sensitive agricultural practices on almost 30 million hectares found an average 93% increase in per-hectare food production.[295] In Asia, proportional yield increases were greatest in rain-fed systems, but irrigated systems have seen small cereal yield increases combined with added production from additional productive system components (such as fish in rice, vegetables on dykes).

Some of the indigenous farming systems that have potential for sustainable agriculture include (i) forest gardens; (ii) swidden agriculture (within carrying capacity); (iii) transhuman pastoralism; (iv) integrated agriculture and aquaculture; (v) traditional soil fertility management; (vi) integrated pest management; (vii) weed management; (viii) genetic resource management; (ix) microclimate management; and (x) local classifications of soils and soil types.[296] Other authors include crop rotation, use of cover crops, no-till and low-till farming, nutrient management, and rotational grazing used in developed countries.[297] Organic farming is another variant of sustainable agriculture and is one of the fastest-growing markets in the US and Europe. Organic farmers in the US

report the market growing at more than 5% per annum, and almost all report receiving premium prices for their products.[298]

Typical of the poor penetration of sustainable agriculture in Asia and the Pacific, only 0.4% of Thailand's farm households and 1% of Japanese farm households are practicing some form of sustainable agriculture.[299] Many of these farmers are involved in a religious or spiritual pursuit of sustainable agriculture, demonstrating the need to reconnect people to the environment. Some are following Thailand's revered monarch who recommends a system of integrated agriculture and aquaculture (30% rice, 30% orchard, 30% pond, and 10% living quarters), which has been found to be 4 times more profitable than rice alone.

Given the relatively small uptake of sustainable agriculture, sustainable forestry, and sustainable fisheries, there are large opportunities for private sector involvement in these sectors in Asia and the Pacific. The "dragon-head" approach in the PRC may be one good model to follow. Value-adding or processing companies work with farming communities to produce the primary products needed of the quality required by providing improved seeds, extension advice on production methods, and assured contracts for the final products. This increases security for the farmers, provides quality raw materials, and can help to protect the environment through improved cultivation methods. Where a premium price can be extracted from processed foods certified to come from sustainable agriculture—similar to what shade grown coffee has demonstrated—it will be in the interest of large food processors to provide similar services to their farm suppliers,

Environmental Employment

The environmental goods and service sector also generates significant new employment opportunities. OECD estimates that it accounts for 1.8 million jobs in the US, another 1.8 million in Germany, and 590,000 in Japan. Contrary to popular belief, taking care of the environment creates new employment opportunities, new investment opportunities, and sustainable economic growth.

Recent studies in the US have found that the environmental sector may be larger than previously thought and extends well beyond traditionally scientific jobs. Two related studies in the US found that that the environmental-protection workforce in the US encompassed some 5.1 million jobs in 2004 (nearly three times the OECD estimate).[300] According to their estimates, the workforce is more than 10 times greater than that of the US pharmaceuticals industry, nearly 6 times greater than the apparel industry, and almost 3 times greater than the chemical industry.

The studies also found that job creation and environmental investment are not only compatible, they are strongly synergistic with dollars invested in environmental spending likely to generate greater than proportionate job benefits. One of the reasons for this is that the environmental industry has a multiplier effect. For instance, the impact of increased sales of air pollution control equipment in Asia will reach far beyond the systems themselves because the sales of these systems include large quantities of purchased products. Large system suppliers purchase fans, motors, material handling systems, steel structures, vessels, pumps, valves, piping, and instrumentation from suppliers. For every full-time employee in an air pollution company, there are 3-4 full-time employees in component companies working to supply its needs.[301]

In addition, jobs created by the environmental industry exist across a broad spectrum of work activities and may be directly or indirectly created. Interestingly, the US studies found that classic environmental jobs (i.e. geoscientists or conservation technicians) constitute only a small portion of the jobs created by environmental protection; the vast majority are standard jobs for accountants, engineers, computer analysts, plumbers, factory workers, truck drivers, mechanics, etc.[302]

Although there are many ways to classify environmental jobs, the simplest definition is any job that reduces environmental impact. Generally, these fall into the following sectors:

(i) earth repair: restoring and rehabilitating degraded, polluted, or even totally obliterated ecosystems;
(ii) environmental survey: assessing, monitoring, and auditing of ecosystems;
(iii) resource renewal: waste management, cleaner production, and recycling/reuse of materials;
(iv) sustainable energy: research, development, and marketing of energy products based on renewable resources;
(v) sustainable communities and cities: architectural, building, industrial design, and planning professions in the design and construction of sustainable schools, shopping centers, transport systems, homes, and commercial buildings;
(vi) sustainable food production: production and processing of food that this uncontaminated by toxic substances, pesticides and radioactive materials.[303]

Remediation activities have to date been the most significant contributor to employment creation within the earth repair sector. This is primarily because of US and European legislation requiring stringent management of contaminated sites, such as the 1980 Superfund (Comprehensive Environmental Response, Compensation and Liability) Act in the US. Restoration of degraded ecosystems is, however, a rapidly growing industry in developed countries. The US remediation industry for industrial and military sites is a $9-billion-per-year business and employs at least 60,000 workers.[304]

Environmental survey focuses on the collection, analysis, and use of information. One of the major changes in this field over the past 20 years has been the use of satellite imagery. The scope of data collected and spatial resolution continue to improve almost to the point that there is more information than users can readily absorb. Another major advance has been the cluster of satellites that provide global positioning systems allowing data collection points to be accurately identified and mapped, a significant advance for monitoring systems that require repeated collection of data. Firms involved in this sector tend to be relatively small, highly skilled, and increasingly reliant on technological advances.

Resource renewal reminds us of the old adage "there is money in muck." The largest waste management firm in the US has annual revenues of more than $12 billion and employs more than 50,000 people.[305] Major strategies employed in this sector are dematerialization, material substitution, repair, reuse and recycling, and waste mining. For every million metric tons of waste processed in the US, up to 600 jobs are created.[306] Generally, it has been found that the greater the degree of waste treatment and processing, the greater the job intensity. In Asia and the Pacific, however, more formal waste collection and treatment processes must provide for the informal sector of ragpickers and other waste scavengers who eke out a living from solid waste dumps.

Concern for net job creation is also exemplified by the sustainable energy sector, where jobs in renewable energy may be viewed as simply replacing fossil fuel-related jobs. However, in the developing world where there are a huge number of people without access to modern energy sources, sustainable energy jobs are likely to be net additions to the employment market. The 1996 "one million roofs" initiative that set a target of installing solar energy on a million buildings throughout the US was estimated to create more than 70,000 new jobs. Investment in energy efficiency in the UK would create more than 50,000 jobs.[307] Wind turbine manufacturing, maintenance, installation and consultancy services account for some 10,000 jobs in Denmark, and another 6,000 jobs exist worldwide in component supply and in the installation of Danish turbines. Grassroots involvement of wind power cooperatives subsidized by the government was a major factor in starting the Danish domination of the wind turbine market worldwide.

The success of sustainable communities will lie in finding suitable transport alternatives to the motorcar. Restricting car access and promoting pedestrian malls in urban areas has generally led to increased retail turnover and jobs. Light rail infrastructure generates more jobs than building roads. Retrofitting urban areas with bicycle paths will not only create jobs but also improve public health. For green buildings, job opportunities exist in all aspects of the construction industry including (i) developing new, environmentally benign materials and production processes; (ii) developing durable, long-lasting products; (iii) training architects in passive solar heating/cooling, water conservation design, and other environmental practices; and (iv) incorporating new ideas and skills into all aspects of building construction.

FINAL WORDS

There is often concern that any push toward sustainability will be at the expense of economic growth and jobs. Experience indicates that the disruptions in economic systems that have occurred constantly throughout history lead to temporary downturns but that new and better ways of doing things have always led to increased growth and new jobs. There is no reason to think that sustainable development will be any different. It is possible to protect the planet and generate profits.

Asia and the Pacific will be the global growth engine for the near future, and manifold opportunities exist for ensuring that this growth is environmentally sound and sustainable. Proactive companies seeking opportunities for beyond-compliance performance in their existing businesses will find profitable openings in eco-efficiency, continuous improvement, energy efficiency, and cleaner production. Paradoxically, the worst performing firms from an environmental perspective will find the easiest path to improved performance and profitability. Experienced environmental auditors consistently find "low-hanging fruit" in such companies where environmental performance can be improved at minimal cost.

For other entrepreneurial firms, "green" business opportunities abound. Each year, at least one billion dollars worth of business in environmental infrastructure, environmentally responsible procurement, renewable energy, and sustainable agriculture and forestry is available for investment and solid financial returns. In the process, millions of new jobs are created. Corporations in Asia and the Pacific need to gear up for these opportunities, as their competitors in Europe and the US are already one step ahead of them and dominate the market. Companies from the region need not wait for technological breakthroughs. There is enough technology and expertise available now to make a giant leap toward a sustainable business model. Of all countries in the region committed to this new direction, Japan is showing the way and could become a global leader in sustainable business models. Other countries, notably the PRC, India, and Republic of Korea will need to move in the same direction or will be left behind.

CHAPTER 6
Emerging Technology Prospects

Technology has long been considered the main driving force in economic development, but today's "technology revolution" is literally changing the world with phenomenal rapidity. Capital is being replaced by knowledge, and knowledge is thought to comprise the "infinite resource."[308] With the onset of this knowledge-based economy, the labor force in modern nations is busy using powerful information systems to create various forms of new knowledge and applying it to solving life's problems. The decoding of the human genome, for instance, was made possible by employing a dozen supercomputers to manage the 3 billion bits of information in the DNA molecule. Progressive corporations have become "knowledge enterprises" in which 70% or more of their assets are knowledge in various forms. For the first time in history, knowledge—the very heart of scientific and technological advances, innovation, and productivity—is being harnessed systematically on a massive scale.

The result is that breakthroughs are appearing everywhere. We can now realistically envision hybrid cars that double fuel efficiency while reducing pollution; fuel cells that promise to replace oil with hydrogen; genetic control over the process of life itself; computer power that is cheap and abundant; mobile communications at lightning speeds; robots acting as servants and caregivers; and so much more to come. This technology revolution is still at an early stage, but the potential for acquiring new forms of knowledge to solve environmental and other problems is so vast that it is limited only by human imagination and will.

While most technological advances originate from the developed nations, the forces of globalization are more closely integrating science and technology into the developing parts of the world like Asia and the Pacific. The PRC, India, Japan, Singapore, and others in the region have become active players in scientific research and commercial development. For instance, Japan is the world's leader in consumer electronics, robotics, and hybrid cars. The Republic of Korea has the globe's most advanced Internet system. Singapore has the world's most sophisticated information infrastructure. Studies confirm that Asia is beginning to rival Europe and the US in patents, scientific publications, and technology in general.[309]

This chapter provides an overview of progress in eight broad fields covering the entire span of scientific and technological innovation: manufacturing and robotics, transportation, the Earth system, space, information technology (IT), e-commerce, medicine and biogenetics, and institutional change. For most fields, the emerging capabilities of three or more of the most "strategic" technologies are summarized and their future prospects for economic development and environmental improvement are evaluated. In all, 44 technologies are reviewed representing major applications based on the underlying capabilities in information systems, biogenetics, nanotechnology, and other common scientific fields, so various combinations often appear. The technologies selected are hardly exhaustive, but they focus on the breakthroughs likely to exert the greatest influence in the years ahead.

The study method uses a "strategic analysis" that draws on a wide range of sources to summarize the state-of-the-art in each technology, focusing on trends and breakthroughs that are likely to advance progress as well as obstacles along the path. Where information is available, data points and

examples are offered on the present use and future growth of each technology. Results of a technology forecasting system—TechCast[310]—are also included to estimate when each technology is likely to enter the mainstream, usually defined as a 30% adoption level, and the anticipated economic potential. In cases where indications differ, the ambiguity is resolved by integrating the diverse information into a reasonable synthesis termed "best forecast."

EVALUATING EMERGING TECHNOLOGIES

From previous technological revolutions—such as the progression from animal power to the internal combustion engine over barely more than a decade— observers have consistently noted that technology is a two-edged sword. For every problem that technology solves, it seems to spawn a new one, often when it is too late to withdraw. There are very few instances in human history—such as Japan's rejection of guns in the 17th century and Europe's current ambivalence toward genetically modified food products—where societies have systematically decided not to adopt a new technology. Accordingly, this report notes the generic environmental problems that may "co-evolve" with the technology revolution and indicates where additional investigation may be needed. Such warnings are believed necessary to counter the ever-hopeful technological optimists who believe that business need not worry about pollution or ecosystem destruction as new technology will make all past environmental concerns obsolete. However, evaluating technologies that are still rapidly evolving also poses some real challenges.

As an example, USEPA has developed guidelines for evaluating emerging technologies in the chemical industry.[311] The evaluation system, called "cleaner technologies substitute assessment," is adaptable to other forms of technology assessment. There are six main components:

(i) process information: physical and chemical properties, manufacturing processes and product formulation, environmental fate, human health hazards, environmental hazards, process safety, market information, international trade issues;
(ii) risk: workplace practices and source release assessment, exposure assessment, and risk characterization;
(iii) competitiveness: regulatory status, performance assessment in meeting functional requirements, and cost analysis;
(iv) conservation: energy impacts and resource conservation;
(v) additional environmental improvement opportunities: pollution prevention opportunities and control technology assessments;
(vi) choosing among alternatives: risk, competitiveness, and conservation; social benefits and costs assessment; and decision information summary (essentially advantages and disadvantages).

UNEP's Production and Consumption Branch also has developed an environmental technology assessment (ETA) to help decision makers understand the likely impact of the use of a new or existing technology. ETA is used to identify technologies that are compatible with sound environmental performance by providing information so that potential environmental problems and costs can be identified and avoided from the outset. The key elements of ETA are the following:

(i) description of the technology: the goal it is intended to satisfy, the characteristics of the technology, and the key stakeholders;
(ii) assessment of the environmental pressure and impacts of using the technology: resources, labor, infrastructure, and supporting technologies required;
(iii) evaluation of environmental risks and significance of the impacts;
(iv) comparative assessment of alternative technologies;
(v) recommendations on technology choices.

In the European Union, transport options were assessed by the project titled Forecasting and Assessment of New Technologies and Transport Systems and their Impacts on the Environment (FANTASIE).[312] The technique used for forecasting involved a hierarchical approach building up from basic technologies and technology applications to vehicle concepts, then transport concepts, and finally transport systems. After several false starts that proved too complicated, the assessment essentially opted for a simple multi-criteria analysis based on expert judgment.

The technology assessment in this report attempts to combine aspects of these approaches, albeit in a fairly unstructured manner. Nevertheless, where significant environmental implications are identified, the lack of a rigorous impact assessment is noted and more extensive and rigorous analysis, including considerable public input, is warranted.

Manufacturing and Robotics

Mass customization: Progressive companies are using "virtual integration" to respond quickly to an explosion of diverse tastes while reducing costs. By taking customer orders online via the Internet and using automated production methods, manufacturers can eliminate sales outlets, salespeople, inventory, production work, and other "industrial age" functions. The result is higher quality, lower-priced customized goods delivered in days while earning greater returns for investors. "Mass customization will proceed with gravitational force," said Alvin Toffler, a renowned futurist. "People desire greater individuality as they become more affluent and technology now allows it." A leader in this field also has predicted that, "…mass customization will be as important in the 21st century as mass production was in the 20th."[313]

As of 2004, total online purchases were only about 6% of retail sales. Not all of this is customized, so mass customization is still considerably below mainstream usage for various reasons. Business practices remain cumbersome, and sensitive issues are involved such as threats to the privacy and security of customers buying online.

But the underlying technologies that support customization—e-tailing, more powerful IT systems, broadband, and computerized manufacturing—are all expected to reach critical mass by 2010. Companies are currently selling customized personal computers, jeans, shoes, cars, bicycles, and other goods in different colors, sizes, materials, and options to suit different tastes. Mass customization is also used to offer a diversity of financial services, interactive TV, music, hotel services, and other intangibles.

TechCast estimates that mass customization will reach the 30% "mainstream" adoption rate and a potential global market of about $250 billion by 2012. A variety of forecasts point toward 2010–2012 as the take-off period when mass customization is likely to reach mainstream use in developed countries. Because this technology applies to everything from toothpaste to services, it should have a dramatic impact on economies, spurring growth, paring costs, satisfying needs for convenience, and reducing environmental impacts through everything from lower paper use to a wide range of other efficiency gains in production and transport.

Micro-machines: Tiny machines with micro-electro-mechanical systems (MEMS) are made using the same photolithography method that creates silicon chips. MEMS are used successfully for air bag actuators, digital light processors, optical switches, and other applications. Research on MEMS is supported by 600 organizations in business and government, and it is still growing. We are now at the threshold of what one scientist has called "a second silicon revolution."[314]

Although micro-machines were originally thought of as simply smaller versions of full-scale machines, the parallel advance of nanotechnology (see below) and bioengineering is creating a far greater spectrum of possibilities. "Hybrid" versions of MEMS, often combining nanotechnology and biotechnology features, are used to form clever arrangements of atoms that perform machine-like tasks. All these technologies are rapidly converging to form fully functioning, intelligently controlled microscopic machines—tiny robots—the size of a grain of rice, or even a speck of sand or a microorganism. This is the real race to the bottom.

As our ability to manage the world of the infinitesimally small expands, the range of applications is also growing to encompass a variety of new medical treatments, small control devices, sensors, and endless other uses. For instance, MEMS may be used to cleanse the human body of dangerous cells, to create clouds of "smart dust" able to perform intelligent tasks, and to form networks of sensors that communicate with one another. Estimates put the Japanese MEMS market at roughly $2 billion by 2010, and the global market is expected to increase from $13 billion in 1996 to over $34 billion by 2020.[315] TechCast estimates mainstream use by 2016, producing a global market of $65 billion. The best forecast is that MEMS are likely to become widely used about 2015 with a global market of $25 billion, maturing at $60–$70 billion later.

Nanotechnology: The "nanosphere" consists of objects measured in one billionth of a meter and is now undergoing a revolution as research increasingly yields control over this tiny world. Nanotechnology products currently available include non-stain fabrics, organic light-emitting diodes, nanocomposite materials, nanoemulsion cleansers, nanoscale paints, TV screen coatings, and various industrial processes, and many more specialized and exotic applications are emerging.[316]

The original concept proposed by Drexler[317] outlined how nanomachines, themselves built from atoms, would assemble individual atoms to compile any physical object. That idea now seems limited by physical constraints at the atomic level and is being challenged by other scientists.[318] Instead, much attention is now focused on using carbon nanotubes (elongated Buckminsterfullerenes or "Bucky-balls"), which are carbon molecules with unusual properties. For instance, nanotubes have 100 times the tensile strength of steel at one-sixth the weight, which provides a 600-fold increase in strength-weight ratio. This feature is so extraordinary that it has made the old vision of a "space elevator" feasible. Scientists at Los Alamos Laboratories are designing a satellite that will orbit roughly 100,000 kilometers above a fixed spot on the equator connected to the Earth with a thin film of carbon nanotubes 1 meter wide.[319]

The idea that virtually any type of extraordinary item can be made by manipulating matter at the molecular level has the entire world fascinated. Governments, companies, and venture capitalists pumped $6 billion into nanotechnology research in 2003 alone, producing daily breakthroughs.

The medical applications are particularly promising, based on the ability to control matter at such fine detail. The National Cancer Institute and NASA are funding a $12-million-a-year program to develop "nanosensors" that will monitor the body for problems like cancer and automatically repair damage. The US National Science Foundation estimates that half of all medical treatments and drugs could be affected by nanotechnology. Given the size of the global health care market—measuring several trillion dollars per year—such applications alone will ensure the future of this technology and its many benefits.

One of the largest applications may lie in expanding the power of computers. In addition to their great strength, nanotubes can carry electricity 100 times faster than silicon, can form far smaller transistors, and can spontaneously assemble into precise formations free of error, much the way crystals form. At least two firms are introducing nanotube memory chips that store terabits of data per square centimeter, about a million times the current data densities.[320] If these early examples prove effective, nanotechnology could be a leading candidate to extend the power of computers beyond Moore's law, which is expected to run into physical limits soon.

At least 3,000 nanotechnology patents have been filed since 1996, and the National Science Foundation expects nanotechnology to grow into a $1 trillion market worldwide by 2015.[321] Others estimate the potential market at $1 trillion–$2 trillion when it mainstreams by 2010–2015. TechCast studies forecast nanotechnology to be used in 30% of all products by 2018, plus or minus 6 years. We conclude that nanotechnology is likely to reach mainstream use about 2015, but there is a wide variation in this forecast ranging from 2010–2020. The potential annual market by that time is likely to be in the trillion-dollar range.

Smart robots: Simple versions of mass-produced mobile robots are already used today for manufacturing, delivering mail, vacuuming floors, mowing lawns, and other routine tasks. In 2003, there were over 600,000 personal service robots in households around the world (mostly robotic vacuum cleaners), with 4 million new units projected to join them over the following 3 years.[322] In addition, approximately 800,000 "dumb" robots now work in factories around the world, performing repetitive tasks such as welding and assembly. As computer power, artificial intelligence (AI), and other enabling technologies mature, "intelligent" versions are rapidly being developed that run, walk and climb stairs, speak with humans, and perform complex tasks. Governments and corporations around the world are pouring resources into this new field, and the rate of progress suggests that truly capable robots are likely to serve important roles in industrial work, home services, health care, military, and leisure activities within 5 to 10 years.

The technical challenge is unprecedented, of course. Smart robots require acute sensory devices to understand their environments, speech recognition software that allows accurate and comfortable machine-human conversations, the intelligence to learn and make better decisions, and even to understand and respond appropriately to emotional displays. This requires a high level of AI, a field still in its early stages of development.

Japan leads the industry, primarily because robot pioneers see huge potential in assisting modern societies with aging populations and a shortage of caregivers. Robots are expected to play a personal role as companions for the elderly, providing comfort, reminding them to take medications, and altering authorities if they are in crisis. Today, there are five workers for every senior citizen in OECD nations. By 2020, the ratio will decrease to 3 to 1. In Japan, it will be 2 to 1. Consumer surveys suggest that most people can accept robots in their homes easily, often with enthusiasm.[323] The Government of Japan has provided generous funding for research into AI and humanoid robotics, and Japanese corporations are making rapid advances in this field.

Another driving force in robotics is the military. The American military, for example, has awarded $154 million in research grants to turn all nascent technology into a battlefield package. They are supporting robotic, unmanned tanks, land cruisers, and aerial vehicles, all linked by intelligent sensors and data networks. By the end of this decade, the US could be sending fully functional robotic warplanes into battle with the ability to identify targets and make corrections as the situation changes, and robot soldiers also are in the works![324]

The health care industry is gearing up to serve millions of patients using robots to carry sick people, take temperatures, and draw blood. Most humans lack the ability to be consistent, reliable, and precise and to perform repetitive chores and exert great strength—exactly the tasks at which robots excel. It is these human weaknesses (such as mildly shaky hands) that may make robotic arms increasingly used in complex surgery. For instance, the Da Vinci Surgical System, already in use, is a high-resolution 3D telescope with robotic arms that are inserted into the patient through small incisions.[325]

At the University of Illinois, researchers believe that robots should get out of the factory and onto the farm. Instead of using high-powered, gas-guzzling tractors to weed crops, destroy bugs, take soil tests, or harvest crops, an army of AgAnts communicating with each other and covering the entire field will achieve the same functions and consume less energy. Pesticides could be delivered to plant surfaces in precise doses instead of from airplanes or spray booms that result in drift and wastage. Perfecting farmbots on Earth may also create the technology needed for "terra-forming" on other planets, making them suitable for human occupation. Gastrobots have been suggested that could munch on vegetation, or even flies, as they strive to derive their fuel supply from a microbial fuel cell.[326]

Today's robotics industry is simply a logical outgrowth of the age-old human drive to extend the power of our limited bodies by making machines that are stronger, faster, more agile and precise, and less vulnerable. These unique advantages make robots almost certain to be used where humans cannot perform or are subject to great risk: fire, cold, darkness, radiation, long waits, etc. All these traits suggest robots have a big future in the hostile environments of heavy industry, construction, mining, warfare, and space.

A renowned robotics authority sketched out how this wave of progress is likely to advance. By 2006, 2.1 million robots will be sold as everyday tools to perform routine tasks. By 2010, the boundary between humans and machines will be breached in ways unimaginable to most people today, much as the World Wide Web did 10 years ago, making robots as common as personal computers (PCs). By 2015, one third of all US military vehicles are likely to be unmanned. By 2020, robots should be able to learn and make choices without reprogramming. By 2025, the robot market is likely to exceed the automobile market.[327] TechCast estimates mainstream use at about 2018, with a global annual market potential in the trillion-dollar range.

Intelligent materials: "Intelligent" materials are appearing that offer interesting possibilities for reacting to their environments in adaptive ways. For instance, aircraft wings are being designed that sense and dampen aerodynamic flutter at high frequencies, and other materials control stress in bridges and buildings. Plastics change shape on command, and other materials react to electricity, heat, solar energy, and magnetic fields. Polymers offer advantages in surgery, high-performance textiles, and self-repairing components in vehicles.[328]

Intelligent structures require sensors, some form of decision-making system, and actuators so they can respond to changes in their environments. Advances in micro-machines, AI, biotechnology, nanotechnology, and microcomputers are, however, giving even ordinary materials intelligent features. Some of these systems involve tiny electromechanical devices while others rely on chemical responses.

For instance, "electronic paper" composed of a layer of tiny half-black, half-white balls can display electronic images in real time. Intelligent gels and aerosols are used to control pacemakers and drug delivery systems. Surgical sutures can morph into perfect knots in response to the patient's body heat. Plastic polymers can flex and relax, like artificial muscles that boost the power of soldiers, astronauts, and robots. Sensors in bricks and walls can monitor a building's temperature, vibration, and movement. Clothing can generate electricity as the sun's energy falls on a person's back. Smart plastic labels with radio frequency identification (RFID) tags can trigger warnings and send signals.

The only forecast available for this field is TechCast's estimate that 30% of products will use intelligent materials by 2019, eventually producing a mature market of $94 billion. This is a somewhat exotic technology with valuable but limited applications, so the TechCast data appear reasonable.

Environmental Implications of Expected Advances in Manufacturing and Robotics

Most of the technologies in manufacturing and robotics will help to dematerialize production processes. If minimal raw material can be mined, processed, shipped around the world, and fabricated into products, the outcome clearly will be positive for the environment. For example, some of the possible uses of nanotechnology to positively address current environmental concerns include the following:[329]

(i) better catalysts and solid electrolytes for fuel cells which can use fuels other than hydrogen at ambient temperatures;
(ii) super-strength materials in turbines and wind-generation units subject to storm damage;
(iii) high-performance capacitors and batteries that would complement solar energy systems;
(iv) continued miniaturization (such as continuing the trend from vacuum tube to transistor to microchip) to reduce the use of materials and in information and communication technology progressing toward the paperless office;
(v) passive energy systems such as electrochromic windows that darken automatically as the intensity of sunlight increases;
(vi) thermo-electric devices for geothermal energy production;
(vii) improved ion exchange resins for extracting minerals from waste streams;
(viii) bio-waste as feedstock for the chemical industry.

In December 2003, the joint Royal Society and Royal Academy of Engineering Nanotechnology Working Group in the UK conducted a workshop on the environmental applications and impacts of nanotechnology. Possible positive environmental benefits noted by the participants included (i) the production of paint requiring little or no solvent; (ii) energy-saving applications including infrared reflection to reduce heat loss; (iii) reduced traffic congestion through better sensors and communication technology; (iv) reduced chemicals used in agriculture; (v) improved desalination and filtration; (vi) bioremediation using nanosensors to detect pollutants; and (viii) more precision with catalysts, for example, in fuel cells. Few negatives were noted, although the possible interaction between microbes and nanoparticles does need more research. It was also noted that there are already many nanoparticles in pollution (such as from diesel exhaust fumes) although this is no justification for adding to the load.

The environmental impacts of the expected phenomenal growth in robotics illustrate the dual-edged sword nature of all technological advances. Robots will be able to work in environments where humans should not (e.g., bomb disposal, clearing mine fields, cleaning up contaminated sites, vacuuming up asbestos fibers, painting cars in enclosed spaces, etc.). They will extend the frail powers of humans to restore degraded environments by becoming extensions of our own capabilities and senses (e.g., doing repetitive jobs like cloning plants using tissue culture, conducting continuous monitoring of polluted environments, and even replanting forests). Replacing humans in the workforce may be beneficial, if more interesting and less risky jobs are available to the displaced workers.

However, as glorified computers with arms and legs, robots at the end of their useful lives will face the same disposal issues as the current e-waste problem in developing countries. Hence, it will be important to ensure that recycle-ability is built into the design of robots, as is being done for modern automobiles. Robots will also be major energy users, so renewable energy developments such as gastrobots that would power themselves from waste products processed in fuel cells are important.

Transportation

Automated highways: A conceptual model of automated highways able to control speed, steering, and braking has been developed over the past few years to make more efficient use of existing road networks. Vehicles equipped with special sensors and wireless communication systems would travel over electronically equipped lanes under computer control at closely spaced intervals, perhaps in small convoys or platoons. Although little government support is provided in the US, the EU and Japan are actively pursuing the concept as a way to better manage vehicular traffic.

There certainly are ample traffic management problems to be addressed. Auto congestion in the US consumes five billion hours of delay and productivity losses of $50 billion each year. Highway crashes cause 40,000 fatalities and 5 million injuries annually, costing an additional $150 billion. Similar levels of congestion pervade Asia and the Pacific, and the problem is expected to double by 2020.[330] Building new highways is expensive and intrusive, so automating existing highways offers a potentially cheaper, faster, and possibly safer approach than the continual expansion of endless roads. Automated highways cost less than $6,000 per kilometer, compared to $600,000 or more for 1 kilometer of new highway, and studies indicate that automation would double or even triple highway capacity.[331]

There are doubts about reliability, of course. Technical feasibility has not been proven beyond a few laboratory and controlled test track demonstrations. In one test, cars traveled at high speed—bumper to bumper—with no help from drivers. Carmakers are starting to incorporate navigation, global positioning systems, cameras, crash-avoidance radar, and intelligent cruise-control systems into their luxury models, and they should become far cheaper and easier to use.

Hybrid cars: Under the leadership of Japanese carmakers, this first alternative to the internal combustion engine has been so successful that it seems likely to revolutionize car design. Hybrid autos are powered by a small gasoline engine operating only at high speeds where it is most efficient while a battery powers the vehicle at lower speeds. This results in huge fuel efficiency gains and reductions in pollution. Electric motors drive each wheel, and regenerative braking conserves energy.

Hybrids were more costly at first, but Toyota's second Prius model is comparable to a Camry in size, price, and performance and has a high-tech style that many buyers prefer. The company is building versions for most of its other cars. Ford is planning to build 1 million hybrids by 2007.[332]

The CEO of Ford Motors thinks hybrids could make up 75% of the car market by 2025. The director of global forecasting at J. D. Powers thinks, "…sales should increase dramatically as more hybrid vehicles are built," and a Japanese auto executive has predicted that, "…companies will start earning returns in 3–5 years." A German auto executive warned, however, that, "…internal combustion engines will still have 95% of the car market in 2015 and 85% in 2025." TechCast expects hybrids to reach the 30% adoption level by 2013. Integrating these estimates suggests a best forecast of 30% adoption by 2015, which would easily translate into a global market in the trillion-dollar-range. Hybrids are likely to be a transition technology leading to fuel cells, however, as discussed below.

Fuel cell cars: With the realization that a revolution in transportation design is imminent, the entire auto industry is pouring billions into research on fuel cells, developing test vehicles, and reducing costs through mass production. Fuel cell cars are considered the logical follow-up to hybrids, because both types are similar in many ways. Hybrids and fuel cell cars both use electric motors to drive wheels, batteries to store energy, regenerative braking to conserve it, and may in time use composite bodies that are lighter. Amory Lovins, the well-known authority on sustainable development alternatives, is developing a "hypercar" along these lines with even more advanced features, and expects to be able to increase fuel economy by a factor of 10.[333]

Fuel cell autos are still uneconomical, because the cost of the fuel cell system is estimated at $30,000, to say nothing of the cost of hydrogen. Methods for extracting hydrogen are still being developed and are not yet commercially feasible. These are partly driven by concerns for safety from the risk of hydrogen combustion in a crash. Some contend that hydrogen should be extracted from oil-based fuels as needed rather than stored on board, which also would solve the problem of safety. One method developed in Canada uses a canister to store hydrogen as a hydride, which can be exchanged at fueling stations, also solving the safety problem. The drive to create this promising new market is bringing forth creative solutions, including the use of nanotechnology and cheap plastic photovoltaic cells to split water into hydrogen cheaply. Wind power and other renewable energy sources are also planned for making hydrogen commercially widespread at low cost.

The range of development activity currently underway is impressive. Japan is planning to have five million fuel cell cars in use by 2020, while Germany's Daimler-Chrysler thinks costs will match conventional cars by 2010. General Motors is committed to the technology and hopes to become the first carmaker to sell one million fuel cell cars.[334] One authority on fuel cell autos concluded, "Conventional wisdom is that fuel cell vehicles will progress by 2010 to where hybrids are today, selling hundreds of thousands per year."[335] TechCast estimates fuel cell cars will make up 30% of new car sales by 2022, eventually creating a global market that may reach several trillion dollars.

Maglev trains: Maglev trains that run at speeds of 500 kilometers per hour or more have been tested and debated for decades, but the PRC's introduction of the world's first commercial train in Shanghai may well determine the future of this technology.[336] With a long history of conventional high-speed trains, Europe and Japan have been developing maglev trains for years as a more convenient alternative to short flights between large cities. Maglev uses one third as much energy as conventional rail and 70% less energy than conventional high-speed trains and airplanes.[337] Such trains are less polluting than aircraft, provide immediate access to city centers, and are more comfortable because they ride on a cushion of air.[338]

Critics claim there is little advantage in speed and the costs are too high. Conventional trains are reaching speeds close to maglev, while maglev costs are estimated at $30 million–$50 million per kilometer of track. Some experts believe there is no reason why it has to be more costly and that maintenance and operating costs are actually lower. An improved version called "inductrack" uses passive magnets rather than electrically generated fields, and it also is less expensive to build, maintain, and operate. This controversy is reflected in widely varying degrees of official support across the world. Britain, Germany, and Japan are canceling maglev projects for various reasons while Los Angeles City and the US Department of Transportation are starting demonstration projects. The maglev system in the PRC is popular, but it is subsidized by the government and losing money.

TechCast estimates 30% of heavy traffic corridors in industrialized nations are likely to use maglev trains by 2032 and that the global market should be roughly $85 billion.

Hypersonic planes: The supersonic Concorde may be yesterday's technology, but the prospect of hypersonic flight is alive and well as the global economy increasingly requires people to fly across the world. Despite brilliant advances in IT that will soon make global communications exceedingly vivid and useful, the fact is that travel demand is not lessening but continues to grow, albeit augmented by other technologies.

A new generation of hypersonic planes is being planned with lightweight, highly reliable scramjet engines that suck in oxygen from the atmosphere at high speeds to be burned with hydrocarbon fuels. Hypersonic planes are

also considered attractive as inexpensive space launch vehicles. NASA recently flight-tested its scramjet plane at Mach 10. Governments and corporations are gearing up to deliver these vehicles over the next decade or two, potentially making it possible to reduce flying time from Asia to the US to 3 hours.[339]

Some experts think long-duration hypersonic flights will become common within the next two to three decades. TechCast forecasts they will be used for 30% of long flights by 2030, producing a global annual market demand of $55 billion.

Small aircraft: Although the idea that people would fly to work in private aircraft sounds outrageous, this is now a reality for many people, and it could sweep through modern society. Two trends make it possible. Costs of owning small aircraft are falling dramatically, and technology now makes piloting a small plane almost as easy as driving a car. This is the reason why sales of helicopters and personal jets are soaring in many countries, and trends suggest it may increase to the point of rivaling commercial travel.[340]

The prospect of endless small aircraft flooding the skies certainly would require an overhaul of air traffic control systems. How would thousands of flights in metropolitan areas be controlled? The US Federal Aviation Administration has been experimenting with "free flight" rules in which aircraft are equipped with global positioning, radar, and collision avoidance systems, so they can monitor their location vis-à-vis other aircraft and maintain safe distances. The administration finds that free flight can be safer than controlled flight, and it can vastly increase the carrying capacity of the skies.

Inexpensive aircraft are increasingly available, and a growing number of busy people find them very convenient. A good helicopter can be bought for $150,000— not much more than an expensive auto. Operating costs have also dropped such that a typical helicopter commute to the office only costs roughly $10—again, about the same as driving a car. Air accidents have plunged 90% since the shift from propeller engines to jets, and some planes are equipped with their own parachutes that can float the plane down gently if necessary. Moreover, because today's small planes are easier to control and are equipped with global positioning systems, average people can learn to fly easily.

This may make sense to those who can afford it, but filling the air with an endless blur of small aircraft driven by ordinary people leaves disturbing questions unanswered. Will normal traffic congestion expand to create traffic jams in three dimensions? Are we prepared for the inevitable rise in the death toll from accidents? Do we really want to see fuel, oil, broken parts, waste material of all kinds, and other junk raining down from countless small planes? No forecasts are available, but the growing use of small aircraft is likely to spread despite these controversial issues.

Global shipping: Continued globalization depends on cheap shipping, currently threatened by high and rising fuel costs. This is a huge industry, roughly comparable in size to land travel, so many of the innovations in automotive propulsion technologies—hybrid engines, fuel cells, etc.—could benefit shipping in time.

The global marine economy was $1.1 trillion in 2000 (although this includes offshore oil drilling) and is growing at 3% per year. The largest sector involves the explosion of jumbo-sized cargo ships sporting mechanized systems for "roll-on and roll-off" of shipping containers, largely a result of globalization, with Japan and the Republic of Korea emerging as the dominant shipbuilders. A Japanese firm recently built the largest ore carrier in the world with a capacity of 300,000 tons. The demand for transporting goods by ship increased an average 13% per year along two main trade routes running from Asia to North America and from Asia to Europe. The PRC has recently emerged as a major source of exports to these markets.[341]

The industry is being transformed by many of the same new technologies revolutionizing all fields. Perhaps the most striking innovation is the dramatic impact of the sophisticated online IT systems that are increasingly used for everything from logistics to navigation to security. The concept of the "smart ship" or "intelligent bridge" has emerged in which total access to information is provided to support decision making by the ship's master, owners, managers, shippers, and port management. For example, US customs now requires cargo information to be electronically submitted through an automated manifest system (AMS) 24 hours before containers are loaded on vessels coming into the country. Large shipping companies now provide integrated online logistics management using global IT networks to search and track individual containers from order to delivery.[342]

Because oceans cover two thirds of the Earth, it is to be expected that ecological matters weigh heavily on the industry. A rising tide of microscopic plastic fragments thought to be discharged from ships now permeate most bodies of water, soaking up toxic chemicals that are believed to poison sea life. Tests conservatively estimate their number has tripled since the 1970s, and that marine species eat them readily.[343]

One promising idea involves ocean biomass carbon sequestration. Large regions of the oceans are deficient in the micronutrients needed to support plankton, so it is proposed that ships disperse trace amounts of nutrients, mainly iron, to support plankton blooms. The plankton absorbs carbon dioxide and then sinks to the seabed in weeks to become a permanent part of the Earth. The enormous potential of this concept is noted by the fact that 2,000 gigatons of carbon are contained in the world's forests and landmass, whereas the oceans hold 60,000 gigatons.[344]

Environmental Implications of Transportation Technology Advances

This evaluation draws heavily from the EU's FANTASIE report, published in 2000. The study examined a six-level hierarchy of the transport system, building up from base technologies to transport systems, four growth scenarios, five problem areas (urban passenger transport, urban freight transport, rural passenger mobility, interurban passenger transport, and interurban freight transport), as well as four time frames (out to 2030).

Telematic technologies that include automated highways are regarded as positive for the environment and for safety and efficiency, and they have socio-economic benefits.[345] While there is no doubt that fuel cell technology and hybrid vehicles will reduce local emissions, the ultimate impact depends on the fuel and technology combination chosen and rate of infrastructure development. Full LCA is needed to determine the contributions to resource use and GHG emissions. Thus, fuel cells will surely improve local air quality and reduce urban traffic noise, and regardless of the fuel source chosen, fuel cell efficiency will be about 50% greater than a 1995 petrol engine. Mining, processing, and disposal of catalysts may also be negative for the environment. Private vehicles will still pollute with rubber particles from wheels and bushes, grease from moving parts, plus the inevitable problem of collecting used car bodies for recycling from remote areas and island nations.

Hybrid vehicles linked to fuel cell deployment will enable substantial reductions in resource use, zero emissions in urban areas, and reduced traffic noise. Advanced conventional propulsion systems, followed by fuel cells and hybrid technology combined with lightweight new materials, reduced aerodynamic drag and friction, will gradually improve air quality as the older vehicle fleet is slowly replaced. Nitrogen oxides and particulate emissions in urban areas are projected to fall in Europe to about 14% and 31% of 1995 levels, respectively by 2030 mainly due to the adoption of a highly efficient all-purpose car. Unfortunately, without some form of financial incentive, these new technologies are likely to lead to higher manufacturing costs, and hence, higher cost to the user.

In the small aircraft field, tilt-rotor helicopters that combine the functionality of

helicopters and fixed-wing aircraft are more fuel-efficient and offer considerable noise reduction in urban environments. High-speed rail such as maglev trains have a high electricity demand, and if that electricity is generated from fossil fuels, then the technology has a high environmental impact that must be compared to that of the next-best transport alternative. Close to the rail lines, high-speed trains may also increase urban noise. Supersonic/hypersonic aircraft are unlikely to be accepted because of strongly negative environmental impacts, including carbon dioxide emissions and noise.

Rather surprisingly, some of the environmental impacts not detailed in the FANTASIE report include the indirect negative impacts associated with creating the infrastructure for new transportation systems and to meet growing demand. These include (i) fragmentation of forest areas by road and rail routes; (ii) death and injury of slow-moving wildlife crossing high-speed roads; (iii) soil erosion during construction of road, rail links, and airports with consequent reduction in water quality and siltation of streams and estuaries; (iv) increased risk of hazardous and toxic waste spills as traffic volumes increase; and (v) reduced aesthetics of rural landscapes crisscrossed by transportation infrastructure. These indirect impacts will be particularly important in Asia and the Pacific, where most of the basic infrastructure has yet to be constructed.

Natural Resources

This large field encompasses all those technologies affecting the Earth as an integrated large system: energy, farming, mining, environment, weather, etc. They are combined in one field as many sustainable development alternatives will hinge on breakthroughs in these areas some of which can already be glimpsed.

Alternative energy: Carbon-based fossil fuels presently supply 78% of all energy use; alternative sources include hydro-electricity (6%), biomass (8%), nuclear (6%), and wind and solar (2%). Renewable energy (excluding nuclear) totals 16% and alternative energy is 22%. Hydro electricity is unlikely to grow much further because most rivers are fully exploited and any new dams are controversial, so further growth must come from wind, solar, biomass, and nuclear fission (which remains too distant to be considered here).

Many claim that carbon fuels are still plentiful because new fields and methods are constantly being discovered. The US Geological Survey and the Department of Energy estimate world oil production will last until 2037. The World Energy Outlook 2004 suggests that about $1 trillion is needed for new investment in oil exploration and development to meet projected demand. Primary energy demand is projected to rise by 59% from now until 2030 with 85% of that in the form of fossil fuels. Two thirds of the new demand will come from the developing world, particularly from the PRC and India. The Executive Director of the International Energy Agency has commented, "This analysis shows very clearly that achieving a truly sustainable energy system will depend on technological breakthroughs that radically alter how we produce and use energy."[346]

There already are preliminary signs that oil is in decline. The same method that correctly forecast US oil production would peak in the 1970s now indicates global supplies will peak this decade.[347] The timing of the peak is important, because it means that substitutes must start taking a larger share of the increasing demand for energy once the peak is reached.

Some alternative fuels are now competitive, and further advances along with rising oil prices suggest that alternative energy supply is likely to increase substantially in the near future. Developing nations are starting to use large amounts of oil, which is one reason why prices have been driven up in recent years. Meanwhile, the cost of alternatives is dropping. Wind power now matches oil in cost of electricity production, which is why wind farms are appearing throughout the world.[348] The cost of solar photovoltaic cells is falling, and there are good prospects for cheap plastic versions that should soon make the technology economically viable.[349] Although nuclear power was considered taboo in much of the world from the 1970s onward, the looming oil crisis has resurrected interest. The PRC alone is planning to build 30 nuclear reactors.[350]

Hydrogen is enjoying global attention as a common carrier of energy, but (as noted above) methods for producing hydrogen affordably have to be developed. For instance, fresh water must be used for hydrolysis because the energy required to split seawater into hydrogen increases tenfold. A variety of methods is being developed to use solar energy to split water into hydrogen and oxygen, usually involving nanotechnology and cheap plastic photovoltaic cells. One method developed in England uses combinations of different solar cells to capture energy throughout the ultraviolet spectrum. Researchers think such a system on a garage roof could provide enough hydrogen to power a car 20,000 kilometers per year. Scientists warn that hydrogen could leak into the atmosphere and disrupt the ozone layer, while others note that producing hydrogen from oil and coal would continue to release carbon dioxide.

Overall, the use of alternative energy is growing at a rate of 30% per year.[351] As oil prices continue to rise and the cost of alternatives falls with further technical advances, it seems likely that the era of oil dependency will run its course in two to three decades. TechCast has completed two different studies that both converge on 2017 as the time when 30% of all energy will be derived from alternative sources.

Distributed power: Prominent failures of centralized electrical power systems have heightened interest in "distributed" power grids that are believed to be more reliable. The August 2003 blackout in the Northeast US was the fourth catastrophic failure of the power grid in a decade. It was followed in September of the same year by a blackout in Italy and another one in Scandinavia.

Distributed grids are organized as self-managed networks that can isolate failures in small areas, but they can also carry heavy loads for long distances. The concept is attractive because it can reduce transmission costs, the risk and severity of failures, and vulnerability to sabotage. This approach requires a fine network of small, local power sources, however, which takes a long time to develop. New home construction in developed countries often includes solar panels and other alternative energy sources, and it is increasingly common to allow people to sell surplus power to the grid.

Based on TechCast estimates and other forecasts,[352] we foresee that the amount of power derived from distributed grids is likely to increase from the present level of 7% to 30% by about 2021, plus or minus 5 years.

Genetically modified foods: A convergence of biotechnology and agriculture has created a new field of "life sciences" with huge potential for designing plants and animals that grow faster, resist disease, are self-fertilizing, and contain more nutrients—genetically modified foods (GMF) or GMO. There also are early signs that it may be possible to create foods—"neutraceuticals" or "therapeutic foods"—that enhance natural ingredients to alleviate chronic illness. For example, the tomato plant has been genetically engineered to produce anticancer nutrients, and eggs have been modified to produce cholesterol-lowering substances.

Progress is slow at present due to fear of manipulating such basic functions as the code to life. A majority of Europeans reject the concept causing stores to phase out GMF. Even in the US where the public seems complacent, one survey found 38% of Americans would use genetically altered food, while 56% would not. Producers do not yet label GMF as such which concerns many people.

In poor regions of the globe, however, population growth on limited farmland will require huge increases in crop yields to feed a projected increase of 3 billion even as hunger continues as a serious problem. Many current technologies use genetically engineered strains such as drugs (insulin) and enzymes (yeast), so the concept is not new but rather a matter of application on a vastly larger scale.

More rigorous testing is underway to examine safety concerns, and accurate labeling is needed before public trust will allow this sensitive technology to expand. Nevertheless, more than half of all US corn, soybean, and cotton crops already use genetically altered seed, and Britain approved its first use of GMF recently, which was considered a pivotal event. Within 5 years, 10 million farmers in 25 nations are expected to plant 100 million hectares of GMF crops.[353] Given the politically charged nature of this technology, it is hard to forecast when GMF will enter mainstream use.

Sustainable cities: Urban areas around the globe are reeling from population growth, congestion, higher energy costs, pollution, and the need to attract business by becoming congenial cultural attractions. To stave off disaster, many governments and their citizens are defining a new model of "sustainable cities" to manage these rising forces.

For example, the government of Sydney, Australia is engaging leaders from all segments of society to plan a 30-year strategy for making the city "bigger, greener, and sustainable." One element of the plan is to make the city more compact to ease transportation and energy use, while also absorbing a 20% influx of new citizens by 2020. Public transport is expected to relieve congestion while decreasing energy use and pollution. The need for more power is to be provided by solar cells mounted on roofs of homes and offices and by improving energy efficiency. [354]

Technical innovations are also emerging to help. A new type of paint that soaks up noxious vehicle exhausts is now available in Europe. Made of a silicon-based polymer that last 10 years, dangerous gases like nitrous oxide enter the paint, where they combine with nanoparticles of titanium dioxide to produce nitric acid that is washed away by rain. When tested in Milan, air pollution dropped 60% and residents said it became noticeably easier to breathe. [355]

Progressive corporations also are choosing to build sustainable office buildings and other facilities because "green design" is proving to be less expensive in the long term. Ford 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 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 sells excess energy to the electrical grid. In Malaysia, a new skyscraper uses louvered windows and sky gardens to cool air.

Various experiments are also advancing the science of managing urban ecosystems. Hyacinths are grown by the city of San Diego to treat sewage and are then used for fuel, animal feed, and paper. Disneyworld in Florida has demonstrated the feasibility of creating small shrimp farms that recycle sewage. Sunflowers have been shown to be capable of absorbing 98% of lead from a contaminated site, and the brake fern can absorb high levels of arsenic and thrive.

No forecasts are available, but as pressures cause city officials to consider alternatives, solutions of this type could easily grow to dominate the future of urban management.

Desalinization: Clean water supplies already are scarce in many parts of the world, and the problem is growing. Water use has increased sixfold worldwide over the past century, and half of the world uses unsafe water which causes five million deaths each year.[356] Fortune magazine has predicted that, "Water promises to be in the 21st century what oil was in the 20th century."[357]

Desalinized water was expensive in the past, but it is now becoming an economically viable option with improved technology and better management. Costs have dropped from $5/liter in 1950, to $1/liter in 1960, and they are now approaching less than $0.01 per liter.[358] New desalinization plant construction is expected to represent an investment of $70 billion over the next 20 years.[359]

Organic farming: Despite millennia of natural cultivation, organic farming is one of those promising fields tainted by the disinformation that it offers unrealistic, altruistic claims. The use of increasingly sophisticated chemical fertilizers and pesticides doubled yields over the past 40 years while reducing costs by 40%, so some fear that abandoning these methods will again restrict output.

However, advocates of organic farming contend that chemical fertilizers and pesticides destroy microorganisms in the soil and develop resistance in pests, creating a vicious cycle in which yields drop in time and costs increase as more chemicals are needed. One study found that chemical farming has degraded soil on 40% of the world's farms, and 10 million hectares of land are lost to farming each year.[360]

Another analysis shows that organic farming can use less energy, maintain high crop yields, improve the soil, produce higher profits, reduce drought and erosion, and protect the environment.[361] Many corporate giants are now embracing organic methods, which has added credibility to the technology, and opinion surveys in the US and Europe show that 90% of the public favors organic produce. These trends have caused the organic food market in North America and Europe to grow at 30% per year. As the middle class from Asia and the Pacific expands and consumes and pays greater attention to what they eat, the market in this region also can be expected to grow rapidly.

TechCast studies estimate 30% of farmland globally is likely to be cultivated using organic methods by 2020.

Precision farming: Precision farming involves the computerized control of irrigation, seed, fertilizer, and pesticides to suit variations in land, as guided by global positioning and other information systems. Farmland differs enormously in its grade and fertility; this approach allows farmers to optimize treatment of the soil as it varies meter by meter while minimizing use of labor and resources. Some aspects of precision farming have been growing for years because farmers find it helps reduce the cost of chemical inputs, raises yields, improves crop rotation management, reduces soil compaction, and increases land value.[362] The development of robots (farmbots) discussed earlier will accelerate this technology.

The initial cost is expensive for many farmers, the knowledge needed is daunting, and it also is not clear which technology, soil types, crops, and other conditions work best.[363] These requirements make the practice best suited to large corporate farms that have the investment capital and are able to manage sophisticated information systems.[364]

About 20% of farmers in the US are adopting these practices, and the field is almost certain to grow.[365] TechCast estimates this technology to reach mainstream use at about 2020.

Mining and refining: The enormous environmental and economic significance of the extractive industries is illustrated by the fact that each citizen in a developed country is supported by 102,000 kilograms of minerals, metals, and fuels each year, amounting to 7.8 million kilograms over a lifetime. While this essential function is today performed in industrialized nations with remarkable efficiency, safety, and greatly increased environmental concern, undeveloped parts of the globe continue to operate under primitive conditions lacking capital, advanced technology, or good management. With burgeoning demand for energy, the PRC regularly suffers the deaths of 5,000 miners per year, accounting for 80% of the world's total, though it only produces 35% of mining output. Some 600,000 miners currently suffer from black lung disease, and that number is growing by 70,000 per year. Coal, perhaps the dirtiest and least effective energy source, supplies two-thirds of the PRC's energy and 80% of its electricity. Coal smoke from factories and households hangs over modern cities like Shanghai, contributing to respiratory ailments and coating everything in a film of black dust, reminiscent of London in the 1800s.[366]

In contrast, Africa, Australia, Canada, and the US lead the world in creating modern mining operations, and Latin America and the Pacific are gaining rapidly. As a whole,

the industry has witnessed a 68% decrease in commodity prices over the past 35 years even as output has grown by a similar amount. Safety in modern mines has improved to the point where accidents are rare and the risk of fatalities has plunged. Environmental safeguards are now completely integrated into the entire production process—from the initial operations through to land restoration—with the goal of zero environmental impact.

These improvements are the result of the extractive industry's adoption of a range of emerging technologies from the fields of robotics, IT, and bioengineering. Possibly the biggest recent breakthrough is the increasing automation of equipment used for drilling at the mine face; loading ore and debris; hauling it to the surface; and processing ore into metals, minerals, and energy. In addition to vastly improving efficiency and eliminating dangers to miners, automated equipment has been found to reduce wear on machinery and decrease maintenance costs even as it operates round the clock without light, seven days a week. Bioengineering is drawn upon to develop biological processes for extracting minerals and metals from ore and remediating contamination at mines. Sophisticated information technology—including fiber-optic cables, global positioning systems, neural networks, computerized equipment, Internet-based communications, and 3D displays—are used to explore geological areas, create databases of the results, determine where and how to drill and blast, control mining equipment, communicate among personnel, and control processing.[367]

The need to transfer these sophisticated capabilities to developing nations is urgent, obviously, but they depend on sufficient capital, good management, strong legislation, and political leadership. Some developing nations are improving mining industries by privatizing state-owned companies, encouraging foreign investment, reducing tax rates, decreasing trade barriers, and streamlining government policies which should move this crucial industry in the right direction. As indicated, the technologies described have already been mainstreamed in many parts of the world, and they can be expected to find increasing application in Asia and the Pacific in years to come.

Environmental Implications of Natural Resources Technologies

While energy is a crucial underpinning of modern economies, few people in the past considered the environmental effects of how energy is generated. Today, the prospect of global climate change due to excessive carbon dioxide emissions, the looming peak in oil production, and concerns over the security of energy supplies mean that the environmental impact of energy has a primary concern around the world. While nonfossil-fuel alternative sources of energy may address carbon dioxide emissions, this does not mean that such sources are devoid of environmental impacts.

For example, solar energy may be "clean" during the life of a solar cell, but this ignores the environmental effects of mining the silicon (the Earth's second most abundant element), fabricating the solar cells, constructing the solar panel structure, and disposing of the used materials once their useful life is completed. Nevertheless, any negative environmental impact should be compared with the fossil fuel alternative which not only has these impacts but also results in highly polluting or damaging emissions. One of the other major advantages of solar thermal, solar photovoltaic, and solar passive energy systems is that they do not require an extensive electricity grid. However, distributed solar electric systems do require backup batteries for which disposal and recycling are significant environmental issues, especially in Asia and the Pacific.

Of all renewable energy sources, probably none is more controversial from an environmental perspective than hydropower, especially when derived from dams. The environmental impacts of hydro-electric dams include (i) alterations to aquatic ecology, especially fisheries; (ii) deforestation of the impoundment area; (iii) erosion and sedimentation from borrow areas for the dam and downstream from the dam due to higher than normal flows; (iv) water quality problems, especially where vegetation is not removed from the impoundment area, including extensive anoxic zones at depth; and (v) loss of unique natural systems through both inundation and changes in downstream hydrology. Run-of-the-river hydroelectric schemes and mini-hydro schemes have fewer environmental issues, but they are still not negligible. Very large hydropower schemes such as the Three Gorges Dam in the PRC have additional environmental issues such as increasing the risk of seismic activity and the possibility of catastrophic floods. Such large dams also have considerable social impacts as more than 1 million people were relocated from the Three Gorges impoundment zone.

Wind generation, currently the fastest-growing area in alternative energy, has issues of noise, bird kills, and aesthetic degradation—not to mention the environmental issues of creating the materials for the various components of the mill. For all forms of grid-based electricity generation, regardless of the source, environmental impacts are also experienced from the transmission lines, especially where they pass through ecologically fragile areas such as forests. There has been extensive investigation of the environmental impacts of the electrical fields surrounding high-voltage transmission lines because they may have negative impacts on all biological systems. To date, no significant danger has been proven, but concerns remain, not the least of which are from families living under or close to transmission lines.

As for the hydrogen economy, much will depend on where the hydrogen comes from. Hydrogen is really only a storage and release form of energy rather than an energy source in its own right. If the original source of hydrogen is from an industrial process or from fossil fuels, then its advantage of releasing only water when it is consumed is reduced (although still better than burning fossil fuels). The real environmental benefits of using hydrogen as a fuel come from generating hydrogen from a renewable energy source, such as solar energy, and converting it to usable energy in a fuel cell. As a fuel cell converts hydrogen directly into electricity without burning it to produce waste heat, there is a high thermodynamic efficiency and a near-zero emission of pollutants. In vehicle applications, fuel cells also offer less traffic noise and low maintenance requirements. The other advantage of fuel cells is that they can be scaled up from small ones powering laptops to 250 kilowatt units, enough to provide electricity through a distributed grid to 50 to 60 homes at US levels of consumption. As noted, distributed grids offer considerable security and provide for the sale of surplus power from home or office installations back into the grid.

In many ways, nuclear energy could be considered as an alternative energy source although it remains quite controversial in many parts of the world, especially following the Chernobyl disaster in 1986. The principal concern rests with disposing of the waste products and the contaminated building structure once the plant is decommissioned. There is yet no generally accepted method of waste disposal, as many thousands of years are required for nuclear waste to become harmless, and there are few places in the world that can be guaranteed as safe waste disposal sites for such a long time. Even more controversial is fusion energy, though both fusion and fission are still many years from commercial development.

Genetic engineering of the food supply has raised considerable concern over environmental and health effects. Life science corporations claim that their new biotechnology products will make agriculture sustainable, eliminate world hunger, cure disease, and vastly improve public health. Opponents of GMOs are wary of these claims, and they are increasingly able to stop biotechnology in its tracks. In theory, breeders could turn out plants and animals that would (i) thrive in areas previously marginal or unsuitable for agriculture; (ii) double or triple agricultural productivity (thus reducing the

area of forests cleared for agriculture); and (iii) require fewer pesticides, herbicides, antibiotics, or other chemicals that are increasingly polluting the environment. Ruminants could be bred to produce fewer GHGs, or pigs could be bred to produce less phosphorus in their excrement. Temperate climate farm animals such as high-yielding dairy cows could be bred to withstand tropical temperatures rather than being confined to air-conditioned sheds. In 2000, a cloned Jersey cow was born with genes for producing lysostaphin, a protein that kills Staphylococcus aureus bacteria, a leading cause of mastitis in dairy cows that costs the US dairy industry $1.7 billion annually. Hence, there is considerable potential for using biotechnology for environmental improvement.

The fundamental concern is that, even as the science of genomics is demonstrating that there is very little genetic difference between species, animal and even human genes are being randomly inserted into the chromosomes of plants, fish, and animals creating previously unimaginable transgenic life forms. The species barrier that formerly stopped unlike life forms from reproducing with each other has been shredded. The long-term implications of removing species barriers and introducing common genes into a wide range of crops or animals are unknown but could include (i) diseases that can easily cross the species barrier (as HIV/AIDS, Ebola, and Bovine Spongy Encephalitis are believed to have done); (ii) disease pandemics targeting the common gene across many species; and (iii) reduction in biological diversity, and hence, increased risk of species and genetic loss.

Other possible environmental problems include (i) the transmission of antibiotic resistance to bacteria in the wild; (ii) the release of larger or more competitive domesticated animals (such as genetically modified salmon) into ecosystems, where they could wipe out native species; (iii) creation of superweeds or superpests; (iv) cross-pollination of related native species or organically farmed varieties by GMOs; (v) increased pesticide or herbicide residues in soils and on crops; (vi) damage to beneficial insects and soil microorganisms; and (vii) creation of new viruses and bacteria due to mutation of GMOs into more virulent forms. [368]

As many of the risks to the environment may be irreversible and relate to the very basis of life, risk assessment techniques will need to be very rigorously applied if the biotech industry is to expand and reach its potential. Normal environmental impact assessment procedures may not be adequate, at least in developing countries. The case of the Monarch butterfly is instructive in this regard. Monarch butterflies are fascinating because of their long migrations and habit of wintering at a few places in Mexico. They feed almost exclusively on milkweed, which grows around the margins of cornfields. In 2000, there was widespread concern that preliminary work showed that the pollen from genetically modified corn was lethal to Monarch butterflies which if true put about 50% of the population of this remarkable species at risk. In some respects, it was not surprising that a modification specifically aimed at delivering a toxin to the European corn borer (a moth larvae) would also affect butterfly larvae. The furor that this case raised forced the US government to take action. Eventually it was found that only one variety of the modified corn was lethal to butterfly larvae, and fortunately this variety did not sell well in the US. Hence, a lucky break rather than serious risk assessment and regulation protected the Monarch butterfly.[369]

Bioprospecting was initially held out as the potential savior of biological diversity globally as "gene hunters" fanned out across the globe looking for extreme genes or lost relatives of modern species. Following adoption of the Convention on Biological Diversity in 1992, the third Conference of the Parties in November 1996 launched the Biotrade Initiative, to cover bioprospecting, non-timber forest products, and ecotourism. However, with a few notable exceptions, bioprospecting has consumed a large amount of investor funds with few blockbuster products identified.

Desalinization is another good example of a technology that when viewed very narrowly appears to have no significant environmental impacts and could really help people living in arid zones. However, desalinization is extremely energy-intensive and could only be regarded as environmentally sound if the energy source was renewable. In addition, an excessive concentration of desalinization plants along a coastal strip could result in disruptions to the aquatic ecology from disposal of waste brine.

The Research Institute of Organic Agriculture in Switzerland completed a 21-year study that showed organic farming is efficient, saves energy, conserves biodiversity, and maintains healthy soils for generations.[370] Crop yields, on average, were 20% lower than conventional fields, but the ecological and efficiency gains made up for this reduction. Not all crops did equally well, however, as potato yields were 60% lower than on conventional fields. Organic soils had up to three times as many earthworms, twice as many insects and 40% more mycorrhizal fungi colonizing plant roots. Soil microbes increased their activity, transforming organic material into new plant biomass faster than microbes in conventional plots. Organic plots also had 10 times as many weed species as plots sprayed with herbicides.

Precision farming and farmbots juxtaposed against organic farming clearly demonstrate the need to make careful technology choices in an area as important as how we grow our food. While precision farming could reduce the use of chemicals and fertilizer, organic farming can make even deeper cuts in their use. The crucial issue is whether organic farming can achieve yields equivalent to those from precision farming. Wherever the balance lies, either approach is likely to be better for the environment than current production systems.

Space

This technology may appear to be of limited interest to Asia and the Pacific and its environmental management. The long-term development of the region, however, could well involve a large and thriving space industry and increasing use of space-based technologies. The PRC has already built a large, profitable, and quite famous sector launching satellites for commercial purposes. Seaborne launches of satellites are taking place in the region's open oceans, along the equator. Additionally, in the longer term of 30 years or more all large economies are likely to be operating space capabilities in much the same way as jet travel is common now.

Lunar exploration: The Moon has long been considered a convenient launching pad for space missions. It is relatively easy to reach, it is easy to escape its mild gravity, and it has almost all materials needed for space ventures including water. The challenges of building and maintaining a permanent base on the Moon are daunting, but not much more so than those of the International Space Station which has been inhabited for years.

The US government recently announced a $12 billion plan to establish a permanent human settlement on the Moon to send men to Mars, and NASA is now working to accomplish this goal.[371] If this were to proceed successfully, a permanent Moon base would have a big impact on business development, medical research, and space exploration. The PRC also plans to pursue its space explorations with a lunar landing within the next decade.

Despite the obstacles, the Moon is likely to be part of the more ambitious attempt to land humans on Mars within the next two decades or so. TechCast puts it at 2025.

Environmental Implications of Space Technologies

Almost by definition, space technologies have little impact on the Earth's environment (though they may have significant impact on the Moon, Mars, and perhaps on other planets). The greatest advantage of space technology to the environment has been the global earth observation systems that through satellite

images provide the best evidence of changes taking place in the Earth's environment.

If occupation of the Moon and Mars is viewed as an opportunity to mine minerals or other materials that are rare on Earth (such as Helium-3 for fusion energy), then there will be major environmental implications for those environments. Perhaps a global moratorium on such uses, as has been in place for the Antarctic, should be negotiated among the nations engaged in space activities.

Space launch facilities are probably the site of greatest potential environmental damage on Earth. Such facilities store large amounts of compressed gases, require extensive building structures and large impervious areas, and house substantial workforces, often working round the clock. They are generally located well away from populated areas to avoid the danger of a launch catastrophe, but this often means that they are located in areas where there may be an impact on fragile ecosystems. Often located in deserts or close to coastal zones where the flat terrain provides for airport runways, there is a risk of discharge of toxic materials and fuel leaks to desert or aquatic ecosystems.

Environmental impacts from space operations include the primary exhaust emissions during take-off, such as carbon monoxide, hydrochloric acid and aluminum oxide from the solid propellant, and carbon dioxide, carbon monoxide, nitrogen oxides, and carbon particulates from the liquid fuel. Short-term water quality and noise impacts are also likely, depending on the proximity to settlements and water bodies. Over the past few decades, considerable space junk has built up in orbit; there is an increasing chance that such junk could imperil orbiting manned stations such as the Mir international space station. Generally, manned space stations return their waste to Earth. As most of the space junk would burn up on re-entry, there is a relatively small possibility of returning material damaging houses or killing people, although a recent launch in the PRC resulted in a piece of an ejected fuel tank crashing into and demolishing a house. (Fortunately, no one was home at the time.)

Information Technology

Biometrics: Biometrics offers a possible solution to the increasing plague of computer viruses, hackers, spam, data theft, and other security risks. Fingerprints, hand geometry, the iris, and facial features are all being used to identify individuals, although fingerprint recognition makes up to 67% of all applications. One expert thinks biometrics is the, "…first killer application since computer firewalls" and believes the market is, "…set to explode."[372]

The technology is not 100% reliable since the human body is infinitely variable. Three percent of people lack readable fingerprints, 7% have eye pigmentation that interferes with iris scans, and face recognition software can be thwarted easily.[373] No biometric measure has proven to be fail-safe, and there is no storehouse yet of iris, hand and face prints such as there is for fingerprints. These problems can be solved in time, and the use of two or more modes of identification has been found to improve accuracy greatly.

The EU, Japan, UK, and US are all implementing national biometric programs to improve security, particularly at airports and borders.[374] The technology is also being used at retail stores to increase security, speed checkout lines, improve customer convenience, and lower operating costs. Individuals are using fingerprint scanners on their PCs or mobile phones to lock and unlock the system, protect stored data, and access e-mail. Applications are growing at an estimated 35% per year, and it is thought that most security systems will consist primarily of biometric measures in about 5 years.[375]

Broadband: Broadband includes digital subscriber line, TV cable, Ethernet, wireless, and satellite communications. The 30% "mainstream" adoption level was reached in US homes about 2004, and growth is continuing rapidly. Speed, however, remains very low in most parts of the world. Lack of rich commercial content and limited interest may impede a high level of adoption that is enjoyed in some nations like Japan and the Republic of Korea that have 70% penetration levels because of government subsidies, faster connections, and sophisticated content. Still, most people like broadband. A US user survey found 85% of broadband users to be happy with their service in contrast to half of radio and TV users.

Broadband only provides faster communications, so the big question is what will it be used for? Some experts think distance learning will prove to be the next big application because of broadband's ability to deliver a multimedia experience. Forecasts indicate the rise of an "intelligent interface" using speech recognition, AI, and virtual robots during the next 10 years that would make computer use conversational and convenient and should expand demand for broadband. Other forecasts suggest that commercial use of the Internet is likely to reach mainstream adoption levels soon, also boosting the use of broadband.[376]

These applications and predictions are encouraged by the relentless increase in broadband speeds. Broadband in the US operates at a paltry 1–3 megabytes per second (Mbps), but telecommunication companies are poised to install cables running at 20 Mbps. Speeds are already at least that fast in developed Asia, and plans are underway to offer 10 gigabytes per second service—a truly remarkable feat. Even wireless services operate at 70 Mbps and could become faster yet.[377] All of this added channel capacity is likely to raise adoption levels to 50% or more in developed nations within this decade connecting the globe with full motion streaming video, face-to-face dialogue, a cornucopia of commercial transactions, and other powerful applications that can only be dreamed of today.[378]

Intelligent interface: As noted, advances in speech recognition, AI, and computer power suggest that the old computer interface (keyboard, mouse, etc.) may yield to an "intelligent interface" in which people simply converse with computers just as they do with other humans. The possibilities are truly vast. We could rely soon on "intelligent agents" or "virtual assistants" to serve as secretaries, tutors, salespeople, and almost all other routine work roles.

The science of AI underlying this concept is not yet able to perform such complex tasks reliably and conveniently. Speech recognition software, for instance, requires time and effort to train and it often makes mistakes. Although Microsoft's CEO earlier said, "…the future lies with computers that talk, see, listen, and learn," he recently added that it will happen, "…not in my lifetime." AI may be brilliant technically but it also lacks the common sense of humans, making some uses annoying (a good example is the "paperclip" on Windows, which almost nobody uses).

A confluence of several breakthroughs seems, however, to be converging to make computers much more user friendly. Speech recognition is now used to replace the maddening touch-tone call centers. It is also used in car control systems, search engines, mobile phones, and a host of other places.[379] Major IT companies are all working to perfect speech recognition by 2010, while work on basic AI is also proceeding apace.[380] Virtual robots, or avatars, are being used to serve as guides, spokespersons, game figures, and other roles that allow people to interact with comfortable virtual personas. The 64-bit chips now coming out offer a new generation of computing power designed for full motion video and speech recognition, and large wall monitors are becoming available to display this rich content.[381] Recent developments in chip technology that do away with the need to connect transistor elements with wires offer potential for even faster processing speeds.

Major transitions in the basic architectures of computing and communications are extremely difficult to grasp, of course, but the trends noted above seem to suggest that we are poised at the cusp of just such a transition. The 1980s saw PCs replace mainframes, the 1990s introduced the Internet, and today the old interface of hunching over a dumb keyboard is gradually being replaced by an intelligent interface.

TechCast estimates that by about 2012, it will be common to converse comfortably with life-sized images of virtual persons while shopping, working, studying, and conducting almost all other social functions.[382]

Pervasive networks: A variety of information systems are connecting autos, home appliances, office equipment, the environment, and almost anything else into intelligent networks of electronically equipped objects that interact with one another. One expert has suggested that, "In 5 to 10 years, computing and communications are going to be free, pervasive, everywhere. It's going to be in your walls, in your cars, on your body."[383]

The very prospect can often leave people feeling alarmed rather than comforted. If networks electronically control common objects, a network failure could render them inoperable or cause them to behave erratically with unimaginable consequences. Surveys show that 90% of people think computers are too complex now, so extending computers throughout life's many systems could further aggravate public concerns.

Like it or not, networks are beginning to pervade our environment. As of 2000, four billion chips were embedded in everything from coffee makers to carburetors. The average car now uses 30 to 50 chips, and the average American home has 200. Fifty nations are creating a global network of weather stations, aircraft, and ships that will monitor the environment continuously. RFID tags are starting to track everything from groceries to pets to children. Wireless home networks are connecting computers, TVs, phones, and appliances. It is estimated that 1 trillion devices of various types will be integrated into a global system by 2015.[384] Most of these will be small, inexpensive chips costing a dollar or so, but others will be more costly which gives some indication of the enormous economic implications.

Quantum computing: The science of quantum mechanics offers a possible successor to silicon in which information is stored and transmitted through individual electrons. The strange behavior of matter at the quantum level makes some of the proposed computational techniques bizarre. For instance, two or more electrons can become entangled in such a way that a change in one instantaneously produces a like change in the other regardless of distance, offering a mechanism for instantaneous teleportation of information. Because of the Heisenberg uncertainty principle, individual electrons can coexist in two places simultaneously, and this feature of superimposition allows a single electron to carry two bits of information. The field is struggling to mature, but promising advances are underway, and the potential is enormous. A quantum physics research scientist who developed the first commercially available quantum-cryptography system in 2001, thinks, "E-commerce will be possible only if quantum communication widely exists."[385]

This is going to prove to be one of the greatest challenges facing humankind. The sheer difficulty of learning how to manage information at the quantum level is tremendous, of course, but there are other obstacles as well. Quantum computing alters the state of atomic particles to store information which requires energy; to do this on a massive scale for big computing tasks may require huge amounts of energy with associated environmental impacts depending on the source. The indeterminate quality of quantum mechanics may, however, make quantum computers more prone to error than electronic computers.[386] Nevertheless, the potential is mind-boggling. A quantum computer could easily complete in seconds a task that takes a silicon-based computer billions of years. Little wonder scientists think it will be at least 10 years and possibly 20 or more before we accomplish this historic breakthrough.[387]

Quantum computing can also permit perfect cryptography. The vast power of quantum computers should enable cracking even the most sophisticated encryption codes in a flash. Conversely, because it is impossible to observe a quantum state without altering it, quantum cryptography can transmit information in a way that detects eavesdropping. This may sound very theoretical, but in fact, the first computer network protected with a quantum security system is up and running at Harvard University.[388]

All major governments, computer corporations, and research institutions are investing heavily in this field, and breakthroughs are occurring daily. The ability to entangle electrons has been demonstrated as has the ability to control super-positioning of electrons in two places simultaneously. Researchers are also able to control the direction in which electrons spin, creating the new field of "spintronics."[389]

There is much, much more to be done, obviously, but the power of quantum computers may be available in a decade or two. If the field fulfills the possibilities now being sketched out, quantum computing could create one the greatest economic markets known, amounting to several trillion dollars globally.

Utility computing: "Utility computing" or "computing on demand" involves the use of large mainframe computers to provide computational power, software applications, security, and other services to a wide range of different customers at distant locations as they need it or "on demand." The concept is taken seriously now because one of the world's largest computer companies has made it the focus of its corporate strategy. This is a huge challenge, but if the complexity of this process can be overcome, computing power could become as convenient and affordable as electricity, water, and phone service.

This is no easy task. Managing the process of intelligently directing central computing power and a maze of application software to different clients, often with incompatible systems, is daunting. Furthermore, corporate clients are often reluctant to become dependent on outside sources for something as strategic as computer services.[390] The advantages of providing a more economically efficient solution to computer needs are so great, however, that many consider this the next frontier. Utility computing allows users access to any type of software from a dumb terminal anywhere without buying and maintaining complex systems. It also puts the responsibility for security on the provider, simplifying the life of IT departments enormously. Most in-house servers are only used at 20% of their capacities and PCs at even less. The typical computer user uses less than 10% of the capability of software.

That is why many firms are starting to provide information utility services. IBM is investing $10 billion in its utility computing strategy which it calls "E-Business on Demand." Hewlett-Packard is developing an "intra-organizational" approach in which large networks of the client's own servers provide utility computing to different departments. And various smaller players are doing very well in this new field.[391]

At the present rate of development, it is estimated that utility computing will enter the mainstream about 2007–2010 and that the market potential will be in the hundreds of billions annually.

Virtual reality: Virtual reality (VR) is one of the more exciting promises of the Information Revolution. The ability to immerse oneself in an artificial electronic environment that simulates the sensory experiences found in commerce, warfare, education, medicine, architecture, and entertainment would appeal to many people. Just as flight simulators are indispensable for training pilots, VR is now used to train physicians, assist surgeons during operations, test the design of buildings and vehicles, allow researchers to analyze data in new ways, and create interactive forms of entertainment.[392] Several improvements are under development including 3D effects, comfortable goggles, and sensory suits.[393] Applications are multiplying as the technology improves and as costs drop.[394]

Imagine a roundtable meeting, with a dozen executives. The discussion is animated. The participants are from 10 different countries and they are all conversing in their own languages, yet all can understand each other, instantly. If an uniformed observer wanted to enter the meeting room, he/she would be

surprised to learn that there is no physical room. It is a "virtual meeting" in which participants are holographic images beamed over the Internet from various locations to a central processor that uses VR programs to arrange the holograms into a composite image. Computerized language translation studies a small number of translated sentences to deduce the linguistic structure of each participant then uses common dictionaries to translate into whatever language each observer prefers. Much of this technology already exists.

Or picture a highly skilled surgeon conducting microsurgery to reattach a severed arm. A nurse mops her sweating brow while 2,000 kilometers away the patient is not aware that the doctor is actually operating a robotic arm on a virtual image of the damaged limb. The twin robotic arm in the remote surgery work swiftly and quietly with identical movements without a doctor present.

Virtual reality is growing at about 30% per year and could enter homes and offices about 2010 allowing people to enjoy the thrill of walking on Mars, far more entertaining games, insightful forms of education, and almost any other experience imaginable. A leading computer scientist thinks it will be routine to hold meetings in full-immersion virtual reality by 2010.[395]

Wireless: The advances in power and speed of wireless communication are so rapid that many think of it as a model of disruptive technology. Telecommunication companies recorded the first-ever decrease in wired phone service in 2001, and it is expected that wireless communications will soon exceed wired messages. Wireless is growing at a rate of 60% per year while PC sales are flat. One of the creators of the Internet said, "The age of this technology has only just begun. The world is going wireless."[396]

Wireless communication is still plagued by slow speed, clashing standards, spotty coverage, small screens, limited storage, and security problems. For instance, the cellular network transmits at 19 kilobytes per second, slower than modems. Wide area protocol, third generation, and Bluetooth were all expected to provide a common standard but have proved to be slow, expensive, and unreliable though technical progress could easily resolve these issues in a few years. The next generation of WiMax[397] is being introduced, running at 70 Mbps and covering an entire city. EvDO is thought to surpass even this level of performance while operating on existing cellular networks.[398] Ultra-wideband is entering the field, offering 1 gigabit-per-second (Gbps) speeds, comparable to the fastest landlines.[399] Little wonder that the list of corporations rushing into this nascent market reads like a "Who's Who" of IT.

By 2005, it is estimated that 90% of all laptops in the US will have wireless access to the Internet, and 60% of all mobile phones should have wireless Internet access by 2007. Experts think wireless will reach 500 Mbps to 10 Gbps by about 2008 and include good security systems. The global market for wireless is expected to reach $1 trillion by 2010. TechCast agrees that wireless will reach 30% penetration by 2008.

Environmental Implications of Information Technology Advances

In principle, information technology offers considerable environmental advantages. If people do not need to physically move from place to place, to go to work (telecommuting), to purchase goods (e-commerce), to connect with suppliers (B2B), to learn (distance education), or travel overseas for meetings, there clearly will be a net gain to the environment. However, social isolation of a generation devoted to communicating with the rest of the world through a computer may be a concern if these trends are taken to their logical conclusion.

The biggest concern with IT is that the reverse side of increasing information processing capacity is an accelerated obsolescence of electronic equipment. Today, there are millions of tons of "e-waste," much of which is being exported to developing countries for partial recycling and final disposal. In the PRC, after manual sorting and disassembly, most of the e-waste is sent to Guangdong and Zhejiang provinces, where refining and metal recovery takes place in relatively primitive conditions. There is particular concern about the health effects of this industry on workers. Much of the material that is not useful is simply dumped either by the roadside or in landfills. The e-waste is first sorted into printed wiring boards, cathode ray tubes, cables, plastics, metals, batteries, liquid crystal displays, and wood. Copper, aluminum, iron, solder, plastics and other materials can be recycled. However, insulation and materials that might surround the useful products are often burned in the open or manually stripped off cables and other parts. Plastics are shredded, washed, dried in the sun, and manually sorted into different qualities.

Manufacturing computers and other electronic equipment involves the complicated assembly of up to 1,000 different materials, some of which are toxic. Toxic materials that are released from e-waste include lead (40% of lead in landfills is from e-waste), cadmium (in cathode ray tubes, as a plastic stabilizer, and in electronic components such as resistors), mercury (in switches, relays, and batteries), chromium, brominated flame retardants, and dioxins and furans (from low temperature incineration). Hence, there is a significant health hazard for ragpickers on landfill sites and for workers extracting and refining metals and plastics. The EU is moving toward phasing out many of these toxic materials and insisting that electronics firms take back their products for responsible recycling and disposal. However, such measures are not yet widespread in Asia and the Pacific. Rethinking computer design to create a "clean computer" is an urgent need, as the volume of e-waste is growing exponentially.

Some of the possible solutions to these waste problems include (i) safe cleaning of chips; (ii) using different base material for printed circuit boards to eliminate the need for flame retardants; (iii) using lead-free solder, nonhalogenated lead wires and plastics; (iv) using recycled resin in all plastic parts; and (v) a wind-up laptop, similar to wind-up radios, that would eliminate the need for batteries. Finally, the expansion of utility computing would help to eliminate the need for every user to own a personal computer. In the longer term, quantum computing may make the current design of computers obsolete, but the energy required may increase environmental impacts unless renewable sources are dominant by the time quantum computing becomes commercial.

E-Commerce

Business-to-business: Competition to reduce costs and speed operations continues to spur the use of electronic connections between suppliers, host companies, distributors, and other business relationships. Incompatible systems and the difficulty of changing business processes are hindering wide adoption which is why B2B was limited to roughly 12% of commercial transactions in 2003. The problem is compounded because while 80% of US companies search online, most still buy offline. For instance, 9 out of 10 steel companies use the Internet to search but only half buy online.[400]

Nevertheless, the advantages are clear and should drive further growth toward mainstreaming the practice over the next few years. Online transactions save 10–30% of costs by reducing labor and inventory, and they already are estimated to save almost $2 trillion per year. Most companies are doing B2B of some type, and interest spans the globe. "There is strong demand to connect the world into a single global market," said an official in Singapore. TechCast estimates that B2B will reach mainstream status of 30% adoption by 2010, while global sales are expected to reach $2.7 trillion.

E-government: Despite the difficulties of adopting leading-edge technologies, governments around the world are streamlining operations and making them available more

conveniently through online processes. In the interim, progress is slow. Most governments have outdated computers and lack the resources for installing expensive, complex Internet systems. E-government requires a large amount of funding upfront that is very difficult to find in fact, 85% of public sector projects to date have been failures.

The need is so great, however, that it is only a matter of time until e-government becomes the norm in modern nations. One IT executive said, "People will always want to browse at shops, but they will never want to wait in line for a driver's license."[401] Governments are running chronic budget deficits, forcing drastic improvements in productivity, while e-government could reduce costs by 25% or more. Electronic procurement systems alone can save 10% of purchasing costs, which amounted $110 billion in the US during 2001.

Most governments are starting to use online systems to collect taxes, process car registration, and even for official signatures. Australia and Singapore transact all government operations online, while 85% of Brazil's tax filings were done online in 2000. TechCast estimates e-government practices will provide 30% of all services to the public by about 2011.

E-tailing: Selling goods and services online was considered a vast frontier during the dot-com boom, but online transactions have not budged past 10% of retail sales. The development of sound business practices and more sophisticated website technologies could still help this infant field grow.

One study found that 70% of virtual shopping carts are abandoned, and many find online shopping cumbersome though another study found that 71% of online consumers say it is more convenient and 83% are satisfied.[402] While these data are hard to reconcile, it may be that online shopping is not comfortable for many people, though regular users tend to like it. Another problem is that distribution channels are hard to break into. For instance, the auto industry has slim profit margins, only dealers can get cars, and selling a new car often requires a trade-in, so it is hard for e-tailers to compete. While 60% of US car buyers do research on the web, only 1% buys online. Although home mortgage sites report heavy traffic, only 2% of mortgages are sold online because people prefer personal dealings. Adding to this list of woes is the fact that the convenient availability of price information tends to drive down rates among competitors.

Secure transactions and broadband have arrived, however, and better displays of merchandise are coming soon which should boost interest. Broadband will soon be in half of all American homes with rapid expansion in Europe and even urban Asia. Biometrics will soon identify computer users with accuracy. Voice recognition and robot salespeople will offer flawless attention to details and convenience. Car radios are being adapted so that occupants can hit a button and place an order while driving. One forecaster expects e-tailing to reach 31% by 2010,[403] while TechCast's forecast calls for mainstream use by 2014.

Entertainment-on-demand: After a decade of struggle, Apple's successful introduction of the iTunes/iPod system seems to have broken the logjam in distributing music and other forms of entertainment online. Better compression techniques and broadband should reduce downloading times in just a few years, allowing people to stream movies in real time. And as storage improves, it will soon be possible to load all available music on one hard drive. By 2010, homes should have TV systems costing less than $100 that can store the equivalent of a video rental store.[404] Major obstacles remain, but the inexorable advance of IT makes this almost inevitable.

One expert expects 42% of all entertainment to be sold online by 2010, but TechCast is more cautious, estimating 30% adoption levels by 2010.

Online publishing: Most publications now offer online versions, but few are profitable because of great resistance to paying for what has come to be regarded as a free good, much like the music industry. This resistance is further aggravated by prices that are no cheaper than hard copies, and competing standards create compatibility problems. The concept of paying a small sum for an article is nice, but micro-payments have not proven feasible. If publishers can find a solution to this dilemma, we may enjoy the enormous advantages of electronic media.

Readers are attracted, because online publications are interactive, searchable, easily updated, and especially useful for texts and reference books. Publishers like the fact that there is no printing cost, no warehousing of inventory, no returns. Broadband and better storage technology should boost use, and sellers are actively searching for distribution methods that work. One publisher gives away books online but sells more hard copies: "We give 3 readers free access for every one who pays, but sales are climbing, so what's the problem?"[405] The Wall Street Journal has almost 1 million paying subscribers to its online version, while The New York Times attracts 10 million visitors to its website who get free content but view paid advertising and pay other charges.

Solutions are bound to appear in time because the advantages of online publishing are too great to resist. TechCast expects 30% of publications to be offered online by 2016.

Virtual education: Virtual education, or distance learning, seems logical because education is a knowledge transferring process, but obstacles abound. Teachers resist changes in their traditional methods, it is hard to convey complex ideas online, and costs still are usually in excess of revenues. A host of universities have canceled programs because the cost of designing one course can exceed $1 million, but upcoming improvements in distance learning technology and delivery methods are likely to overcome these barriers in time.

Most universities are experimenting with approaches to online courses, though only 10% of courses are conducted online. Corporate e-training now accounts for about 30% of classroom training and is expected to exceed 50% soon.[406] Many students prefer a traditional campus experience and find online lectures boring. Some scholars claim virtual education degrades learning, but studies conclude that there is no significant difference with classrooms in terms of learning. Complex or subjective fields may not be appropriate for online formats, but they do offer advantages in teaching languages, mathematics, statistics, information technology, and other highly structured fields. Some claim that a blend of classroom and online methods is best.

Despite this confusion and doubt, virtual education seems likely to play an important role in an emerging era where working adults constitute 50% of college students and information technology pervades life. A 2002 study found that 86% of US students are continuously online using wireless laptops and other devices.[407] It may be that online education will find an important market by reaching out to large numbers of people around the globe, rather than the traditional classroom of 30 students. For instance, the investment in developing online programs and IT systems may be easily justified when reaching an audience numbering in the thousands.

In a study of 3,000 university presidents, 57% said distance learning was equivalent to classroom courses and one third thinks it will be superior in 3 years.[408] Because of the formidable obstacles to changing college practices, however, TechCast thinks it will enter mainstream use at about 2018.

Environmental Implications of Advances in E-Commerce

As indicated for information technology, the main environmental advantages of e-commerce relate to the reduced need for certain commodities, like paper, and for physical movement of goods, materials, and people thus reducing the environmental impact of the transportation system. The downside is the e-waste problems referred to above. On balance, if computing systems become more environmentally sound, e-commerce will have big benefits for the environment but will make a relatively minor

contribution to solving global environmental problems. Even if many of the intermediate transactions can be negotiated online, the final goods produced still need to be physically transported to the ultimate user.

The Basel Action Network[409] closely monitors the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (adopted in 1989 and entered into force in 1992). As one of the first countries to join the Basel Convention, the PRC is now drafting an amendment to the Law on Solid Waste Pollution to avoid the dumping of e-waste. Customs statistics show that the PRC imports about 3–4 million tons of plastic waste every year. However, as e-commerce expands and the infrastructure to support it is replaced at ever-faster rates, there will be other countries in Africa and South Asia that will be willing to provide the manual labor needed to disassemble and recycle the electronic equipment. Some simple solutions such as refilling printer cartridges under controlled conditions may help to avoid some of the worst environmental and health side effects of e-commerce.

Medicine and Biogenetics

Artificial organs: An astonishing array of body parts can now be replaced with artificial equivalents: skin, bone, heart, blood vessels, cochlea, heart valves, pacemakers, knees, hips, etc. For example, metal joints replace approximately 150,000 knees yearly in the US alone. Pressure to develop an increasing range of artificial organs is relentless because transplants of living organs are difficult and not always successful. Hundreds of thousands of people die each year waiting for vital organs, while many others suffer from transplant rejection problems. Using a combination of micro-machines, microchips, materials research, and other new technologies, it is conceivable that bionic parts will soon be available to replace nearly the entire human body.

For example, artificial arms today sense electrical currents generated by muscles and use microchips to translate this information into coordinated movements; more advanced versions are underway that electrically connect the arm to the nervous system itself. A prosthetic leg is being developed with motorized joints, electrical connections to nerves, sensors, and a microprocessor that calculates optimal walking movement. The first brain prosthesis has been used to replace the hippocampus where memories are stored, and "brain pacemakers" are being used to control Parkinson's disease and other disorders. Deaf people have received the first implants in their brainstems to stimulate the nerves that permit hearing. Paraplegics control their TVs and download e-mail through implanted chips. Researchers have even invented simple systems to restore sight; video cameras are installed in eyeglasses, transmitting images to chips implanted in the back of the eye, which are then fed to the optic nerve.[410]

Small chips containing personal information have been implanted in many volunteers, and some think they could be used to keep track of children. One forecast expects 50% of Americans to have some form of implant for tracking and identification by 2025.[411] In March 2002, an electrode was surgically implanted into the median nerve fibers of the left arm of Professor Kevin Warwick, allowing him to control a variety of electronic devices.[412] While the prospect raises ethical issues and concern about the future of humans, it also offers many practical advantages, as in helping the paralyzed communicate. Humans have in recent years accepted implanting devices in their bodies from pacemakers to metallic joints. Connecting the human nervous system to a computer is just a logical progression along this well-worn path.

TechCast estimates the use of artificial organs to reach 30% penetration in 2029 and to create a global market of $70 billion.

Genetic therapy: Genetic therapy may represent the Holy Grail of medicine because so much illness is inherited from the approximately 5,000 genetic disorders that have been identified thus far. The decoding of the human genome has not reached the point where genetic blueprints have been mapped for all these diseases, however, and techniques for altering genetic traits remain crude. Several patients have died in genetic therapy experiments discouraging further research, but the huge potential continues to move progress ahead nonetheless. Fortunately, political forces—and prominent patients suffering from genetic illnesses such as the late US President Ronald Reagan—also help to exert more pressure to move the field forward.

The US alone has 1,300 biotechnology companies employing 100,000 people working on genetic problems. Faster and cheaper methods for mapping individual DNA and comparing it to genomic data banks are making it possible to determine a person's susceptibility to certain diseases. Bone marrow transplants have been used to completely rebuild the immune systems of children, and stem cells have been used to repair genetically damaged organs. The first genetic trial to treat pancreatic cancer has been launched. Genetic therapy recently cured mice of skin cancer. An intriguing new technology has been called a "doctor in a cell" because it uses DNA material to analyze cells for genetic illnesses and repair them. Prominent figures in the field predict that cures for most genetic illnesses will be commonly available by 2025.[413] TechCast estimates genetic therapy will reach 30% of its full potential application by 2016 and become an $80-billion market.

Grown organs: Imagine the benefits of being able to grow genetically identical organs in a laboratory from a patient's own cells. No rejection problems, no organ shortages, and no end to our ability to replace damaged body parts. Human skin, bone, and liver tissues are now produced genetically, and the same basic method is being extended to create entire organs. Grown organs could help the hundreds of thousands of people worldwide who are waiting for organ transplants, and many conditions such as spinal cord injuries, Parkinson's disease, and congestive heart failure, to name a few, could be cured by engineered tissue.

The ethical dilemmas are daunting, however. Much like the prohibition against cloning humans, some governments consider embryonic stem cells to be human life, and therefore, off limits to experimentation, while others are criminalizing therapeutic cloning, a technique used to grow stem cells from embryos. And there is always a risk of provoking other dangers such as cancer.

Yet science is making its way through this moral thicket. Embryonic stem cells can be used to repair damaged cells, cure intractable disease, regenerate organs, and prolong life. A Harvard neurobiologist calls them "magic seeds." Scientists have recently found that they can use stem cells from adults, thus overcoming the moral objections related to embryos. The nascent field of tissue engineering is generating laboratory-grown bone, cartilage, blood vessels, skin, and nerve tissue. An entire jawbone, a nose, and an ear have been built and transplanted into patients. Livers, pancreases, breasts, hearts, and fingers are taking shape in the lab. Researchers have discovered the gene that allows stem cells to remain pluripotent, i.e., able to grow into any cell of the body.

Some scientists claim a veritable body shop of laboratory-grown organs will be available to patients in about 10 to 20 years, while TechCast estimates mainstream use at 2017 and a market of $120 billion. The challenges are Herculean, so this estimate may easily prove optimistic. Our best forecast suggests mainstream use by 2025.

Life extension: Opinions are controversial, but the evidence seems to be accumulating that life extension is possible. Discoveries are being made in extending the life of cells, repairing damage to the body, replacing organs, curing major illnesses, and improving lifestyles. Some authorities claim that human life spans are fixed and are expected to top out at an average of 85 years for genetic reasons. However, a study noted that such claims have consistently been proven wrong, so it is more likely that gains in life span lie ahead.[414] The social consequences would be enormous, but the bulk of evidence and the views of most

authorities suggest the problem can be solved to a large extent.

Researchers have developed telomerase, an enzyme that causes human cells to replicate hundreds of times beyond what was thought to be the limit of cell reproduction, the "Hayflick Limit."[415] Northeastern University has developed a drug that reverses the damage of aging by promoting the growth of natural antioxidants with profound effects. Harvard scientists have found that enzymes called sirtuins are "universal regulators of aging in virtually all living organisms." Genes are being identified that seem to prolong life. Nanotechnology may permit fleets of computer controlled molecular tools smaller than a cell to remove obstructions in arteries, kill cancer cells, and repair the human body.

The World Health Organization estimates that 30% of the global population will be over 80 by 2025, and trends suggest that life span could average 120 to 150 years about the middle of this century.[416] TechCast estimates average life span could reach 100 years in 2044, which may be more realistic.

Personalized medicine: Like most things in life, people vary enormously in their genetic susceptibility to illness, drugs, and other factors, making one-size-fits-all health care often ineffective and at times highly damaging. With the human genome now analyzed carefully, researchers are moving toward genetic tests to determine these differences and thereby permit precise medical treatments that are more effective and produce fewer side effects.

The complexity is staggering. Minute genetic differences must be identified and related causally to specific outcomes from a wide range of drugs. People of different social classes and races have different genetic reactions which could provoke issues involving discrimination. Knowing the genetic susceptibility of people to various ills raises a host of disturbing issues, such as finding insurance coverage and employment, but the prevailing generalized approach is only 40–50% effective and often produces serious side effects. More than 100,000 people die each year in the US from the side effects of drugs, and another 2 million become seriously ill.[417]

Drug companies are developing tests to identify differences in drug response, making genetic testing cheap and convenient, creating computerized information systems to manage this complex array of data on each patient, and developing protocols for individualized treatment.[418] TechCast estimates these advances could enter the mainstream about 2015 to 2020, saving hundreds of billions of dollars and greatly improving health care.

Telemedicine: Medicine is the least-computerized industry in the world with 90% of medical care conducted by paper and telephone suggesting enormous possibilities for improvement. The problem is that health care is a very complex field, and institutional obstacles also hamper it. Hospital administrators are often not interested in telemedicine, insurance does not cover it, many physicians resist computers, and patients are fearful about loss of privacy.

With the advent of out-of-control medical costs in the US and more powerful IT systems, however, conditions in this leading market for medical services are now right for progressive hospitals to embrace new approaches. Kaiser Permanente, the biggest health maintenance organization in the US, is automating its entire chain of hospitals with sophisticated technology. "Point of care" systems manage all patient information, and "virtual care" systems treat them at a distance. Medical records are stored and retrieved electronically. Physician training is now increasingly IT-intensive. Telemedicine could eliminate 80% of the 100,000 deaths per year caused by medical errors, and hospitals should be able to reduce costs by 30–40% while improving service. A recent survey found that 70% of hospitals in the US are planning to adopt telemedicine, and the field is growing by 30–50% per year.[419]

TechCast finds that expert opinion forecasts telemedicine to enter mainstream use by 2013, while the CEO of Waterford Telemedicine Inc. expects it to cover 15% of all health care by 2015.[420] Our best forecast is that the field will grow quickly in the US due to the desperate need to control spiraling health costs, and so the TechCast forecast is more credible. Trends in the US should quickly carry-over into other parts of the world due to the cost savings. Telemedicine thus is likely to prove one of the largest applications of IT, creating a new industry worth approximately $1 trillion–$3 trillion globally.

Environmental Implications of Advances in Medicine and Biogenetics

The main concerns over this field are social, but they have strong environmental implications due to demographics. If millions of poor people are denied access to even basic medicine, but affluent people in developed countries have easy access to artificial organs, gene therapy, grown organs, and personalized medicine, social tensions between rich and poor nations will surely intensify. If developed-country affluent populations can extend their lives to 120 or 150 years, while life expectancy in some developing countries continues to decline because of HIV/AIDS or other epidemics, then difficult moral and ethical questions will need to be answered. The global consumption consequences of longer developed world populations are of environmental concern as well. On the other hand, many medical advances are likely to extend lifespans in the developing world too. If telemedicine saves $800 billion per year in health care costs by 2007, will these savings be diverted to increased private consumption or to improvements in health care in developing countries? If human life can be extended by 40–80 years, the social issues of working lives, retirement ages, and pension schemes will need to be addressed. Insurance companies and actuarial firms will need to change their basic assumptions. Clearly, these moral, ethical, social, and environmental dilemmas, will intensify with time, but the debate to resolve them needs to start urgently.

As noted, the main impact of these technological advances will be indirect, related to increased energy and physical consumption of the developed and developing world, as each person increases their lifespan. Already much of the world's entertainment, tourism, and leisure industry is supported by retired persons from the developed world. As the period of healthy years in retirement increases, then one can expect this age group to considerably expand their consumption. Driven by this demand, the environmental impacts of production processes to meet the needs of the retiree community will also expand.

Institutional Change

This field represents a different type of technology, the "social technology" that executives use to channel behavior into more successful organizations. This is a large field, but our interest is in the historic changes that major social institutions are experiencing today. "Institutional change" goes beyond "organizational change" to focus on entire classes of organizations serving various societal functions: business, government, education, military, and the like. Unlike the management aspects of organizational change—teamwork, leadership, etc.—institutional change concerns the underlying social rules or norms that define how societal functions are structured.[421]

Today, revolutionary information technologies, globalization, and an increasingly knowledge-based economy are transforming all institutions from the mechanistic systems of the Industrial Age to organic systems for the Knowledge Age, and the biggest hurdles lie ahead. The "Stakeholder Collaboration" described below form the central features of this emerging model of institutions for the Knowledge Age.[422]

E-organization: This concept represents the technological dimension of institution change. It defines the movement of information processing from paper and telephone within a hierarchical chain-of-command toward fully integrated information

systems operating in real time—"telework" among "virtual teams," automation of the entire supply chain, "e-tailing" directly with clients via the Internet, and "real-time management." A recent survey of executives found a strongly held consensus that the relentless advance of more powerful information systems seems destined to automate virtually all routine tasks, accelerate the pace of change to approach real time, and create a new organizational transparency.[423] Organizational life in modern nations is rapidly being transformed into integrated IT networks with organizations of all types forming and reforming as self-organizing nodes in this global system.

For example, two thirds of professional workers in the US today report that they work in virtual teams, and 90% think it is more productive and satisfying. About 24% telework full time from home, in the field, at client sites, and elsewhere while 70% telework part time. E-tailing systems help customers place orders directly to factories, automatically updating financial accounts, reducing labor costs and inventory, eliminating retail outlets and salespeople, and delivering cheaper but customized high-quality goods in days. Some companies use a "digital dashboard" or "corporate cockpit" providing real-time strategic information to allow instantaneous organizational control like a flight simulator.

Forecasts show that the main components of an e-organization—B2B, e-tailing, teleworking, etc.—are likely to enter the commercial mainstream during the second half of this decade. Other studies, although preliminary, confirm this time frame.[424] Our best forecast, therefore, is that the e-organization is likely to enter mainstream use during 2006–2010. Because this will amount to a crucial change in the way societies function at the basic organizational level, the economic and social impact is likely to be phenomenal.

Self-organizing systems: This represents the economic dimension of institutional change. The traditional hierarchy can be best understood as a "planned economy" controlled by executives while there is a general move toward "internal market economies" of many small, self-managed units that are better able to harness employee knowledge to manage a new era of exploding complexity and change. The growth of organizational networks, self-managed teams, performance pay, entrepreneurship, internal enterprises, and other trends all point in this direction.

Progressive corporations are increasingly organized as a self-organizing system of countless small entrepreneurial business units held accountable for performance and left free to manage their own operations. Subjective performance appraisals are being replaced by incentive systems, bonuses, and stock plans. The greatest needs of employees today focus on gaining flexibility to better manage time and balance the demands of work and personal lives. A recent survey in the US found that 60% of managers think employee flexibility is more productive. One manager said, "The focus is on whether we produce, not how, when, and where we do it."[425]

Stakeholder collaboration: This can be thought of as the political dimension of the knowledge institution. Organizations are essentially political in that they must form a working coalition of investors, employees, clients, and other stakeholders to succeed. All of these groups should be engaged in collaborative policy decisions to gain their unique resources, support, and knowledge. If carried to its conclusion, the organization can become a "corporate community" that strives to ensure all members share a common vision, a unifying sense of purpose, rights and obligations, acceptable norms of behavior, and sanctions.

One company was struggling with labor unions, environmental groups, local governments, and consumers until it started to work with these critics. The CEO described the change this way: "We viewed outsiders as a nuisance. Now we find that our adversaries help us find creative solutions to intractable problems." WSSD in Johannesburg led to similar partnerships, many involving the private sector.[426] The best examples are provided by the traditional approach of Japanese corporations, which have long focused on collaboration among employees, suppliers, investors, and other constituencies to serve the broader needs of society. Studies indicate that "stakeholder collaboration shows a direct correlation between financial results, customer satisfaction, and employee well-being," and that 80% or more of managers accept the concept because it is clear that support of various groups is essential.[427]

Many corporations around the world cling to the Industrial Age tradition that profit is the main goal of business. This clash between the reigning focus on money versus the escalating social needs of an interconnected world struggling with poverty, congestion, environmental decay, and other massive ills is largely responsible for the predictable backlash against globalization referred to in Chapter 2. It is hard to anticipate when or how this dilemma will be resolved, but there clearly exists a great opportunity for enlightened executives and governments to take the lead.

Environmental Implications of Institutional Change

Generally, the breakthroughs posited for this field should have no significant adverse environmental impacts that would distinguish them from current institutional models. Some environmental benefits can be expected from telecommuting (especially in reduction of transportation impacts), but increased waste also may be generated from a proliferation of "home" offices. In general, however, the new corporate management models incorporate a wider range of concerns in decision making, and engaging more positively with all stakeholders should bode well for the environment.

THE TECHNOLOGICAL FUTURE OF ASIA AND THE PACIFIC

A few cautionary notes are needed to temper the often extravagant promises of technological breakthroughs. Obviously, some of these 44 technologies may not develop successfully due to sheer technical limitations. They could be delayed beyond the time horizons estimated here, or they could play a far smaller role. The hopes for a hydrogen economy, for instance, hinge on finding as yet undeveloped energy-efficient, cost-effective, and environmentally sound methods for extracting hydrogen which could turn out to be exceedingly difficult. Social and political values also are likely to pose obstacles to the profound changes implicit in many of these fields. For example, bioengineering could easily flounder on social barriers, as seen with GMOs in Europe. Further, technical advances almost always introduce some form of environmental damage—often unanticipated. Technology is a two-edged sword, exacting costs and perils as well as great benefits.

Almost all new technologies engender fear of the unknown. For example, before 1896 in the UK, all mechanically propelled vehicles had to be preceded by a man carrying a red flag, 60 meters in front of the vehicle, limiting their pace to walking speed. It is not surprising that emerging technologies today sometimes engender extreme scenarios for our planet's future. What is surprising is that some very technology-savvy observers are predicting not only environmental damage from some of these technologies but nothing short of the total demise of the human race. Although the authors do not share this pessimistic view of the future, it is important for the reader to be aware of these extreme views, if only to put the environmental concerns regarding new technologies into context. Ultimately, all

technology involves choice, and choice is best guided by complete information.

In 1992, 1,700 of the world's top scientists issued a "Warning to Humanity" which includes, "Human beings and the natural world are on a collision course…that may so alter the living world that it will be unable to sustain life in the manner that we know it… No more than one or a few decades remain before the chance to avert the threats we now confront will be lost."[428] Reflecting on the critical issue of biodiversity loss, a renowned ecologist said, "So important are insects and other land-dwelling arthropods that if all were to disappear, humanity probably could not last more than a few months…. The land surface would literally rot."[429] As this graphic description did not reverse the disturbing trends, he repeated his warning with even greater urgency in 1996. "Dominant as no other species has been in the history of life on Earth, Homo sapiens is in the throes of causing a major biological crisis, a mass extinction, the sixth such event to have occurred in the past half billion years. And we, Homo sapiens, may also be among the living dead…not only the agent of the sixth extinction, but also one of its victims. Our species retains hereditary traits that add greatly to our destructive impact. We are tribal and aggressively territorial, intent on private space beyond minimal requirements, and oriented by selfish sexual and reproductive drives. It is possible that intelligence in the wrong kind of species was foreordained to be a fatal combination for the biosphere. Perhaps a law of evolution is that intelligence usually extinguishes itself."[430]

The use of new technologies in the hands of terrorists also worries those concerned about global security. "The 21st-century technologies—genetics, nanotechnology, and robotics—are so powerful that they could spawn whole new classes of accidents and abuses. Most dangerously, for the first time, these forces are widely within the reach of individuals or small groups. They will not require large facilities or rare raw materials. Knowledge alone will enable their use. Thus, we have the possibility not just of weapons of mass destruction but of knowledge-enabled mass destruction, its destructiveness, "…hugely amplified by the power of self-replication…it is no exaggeration to say we are on the cusp of the further perfection of extreme evil, an evil whose possibility spreads well beyond that which weapons of mass destruction bequeathed to the nation-states, on to a surprising and terrible empowerment of extreme individuals."[431]

While some of these concerns will certainly prove parts of our forecasts in error, the greater sweep of this Technological Revolution is almost certain to alter the social order around the globe over the next 20 years or so. As noted earlier, IT is now one of the most powerful forces on Earth, relentlessly transforming business, government, education, public awareness, and other institutions. It is also advancing the growth of knowledge at an unprecedented rate, driving the breakthroughs reviewed above. Some analysts observe an unusual pattern of "double exponential" growth in computer power, genetic coding, and other indices of scientific progress, suggesting that normal expectations of technological change could prove quite conservative in the face of such accelerating rates.[432]

Climate experts are worried that sudden changes due to global warming may result from positive feedback loops that cause runaway climate systems beyond human control.[433] For example, as the frozen tundra melts, methane gas may be released, which is also a potent GHG, adding to the concentration of GHGs in the atmosphere and accelerating global warming. Melting ice caps and glaciers could change the salinity of the oceans and change the global mechanisms exchanging heated water from the tropics with colder water from the poles (the so-called conveyor belt)—disrupting global climate patterns and perhaps sending parts of Europe into a mini Ice Age. As one leading observer puts it, "The present climate pattern is very delicately poised. This system could snap suddenly between very different conditions with an abruptness that is scary."[434]

While the details may be wrong, the broad technological profiles sketched out in this report are very likely to affect Asia and the Pacific dramatically over the next few decades. Drawing on the capabilities of nanotechnology, robotics, mass-customization, and other new fields, manufacturers will soon be able to deliver almost any conceivable product online, quickly, cheaply, and to order. Biogenetics should allow medicine to treat a far greater range of human ills in a decade or two with the efficiency of online systems. The internal combustion engine is likely to yield to hybrids and fuel cell cars along with various other transportation modes, all largely powered by alternative fuels that ease the economic and environmental problems of carbon-based energy. In addition, IT systems are almost certain to improve by another factor of roughly one million over the next 20 years, integrating all of this activity into a seamless web of communicating, computing, learning, working, and shopping that unifies entire societies and the globe.

Thus, there is little doubt that a Technological Revolution roughly along the lines outlined here will play a major role in the transformation of Asia and the Pacific over the next two to three decades. So the main question that requires long and hard thought is simply: Which of these technologies would be most beneficial for the region, and what is the best strategy for developing their capabilities? Only leaders and citizens of the region can answer these questions, but we offer three general guides to thinking on this huge challenge.

First, nations in Asia and the Pacific should reconsider the functioning of their universities, think tanks, and other research institutions. The source of this coming wave of technological innovation is, as always, scientific knowledge, and an entire discipline has risen recently offering powerful insights into the management of knowledge.[435] This report does not examine how research institutions should be redesigned, but it would be useful to ensure that all scientific knowledge is published, discussed, and accessed online conveniently by scholars of the region. It is also urgent that scientists have the resources, freedom, and support needed to collaborate with their peers. It is of the greatest importance that this intellectual energy be guided effectively toward research offering the greatest strategic opportunities for the people of the region. Many scientists and engineers have migrated from the region seeking greater freedom and employment opportunities elsewhere; they need to be encouraged to return home.

Second, corporations from the region should reconsider how effectively they work together in developing commercial products. The era of isolated companies locked in battle with one another over limited markets has yielded to a new ethic of "coopetition," in which alliances offer great strategic advantages. Almost all large corporations today have hundreds of strategic alliances, often with their competitors. The Chinese family capital and investment networks of the region provide an interesting model from which to build. How can corporations from the region work together to develop a regional network that facilitates alliances? Is there a role for trade associations or governments in developing systems designed to match optimal strategic partners with each other? Could this system in time be extended to include collaboration with European and American corporations?

Finally, economic systems themselves are evolving under the imperatives of a knowledge-based world, raising interesting questions about the "Asian economic model." An unusual opportunity may exist for Asia and the Pacific to take the lead in moving the world toward a more sustainable model of economic development.

A decade or so ago, Japan led the world with its commitment to a form of business stressing employee participation and job security, working closely with suppliers for continuous improvement, and supportive alliances with keiretsu partners, all guided by government leadership. These practices highlight the power of a "social technology" described above as stakeholder collaboration. Meanwhile, other companies from the region

gained notoriety for developing a "distributed" enterprise system in which small business units were allowed the autonomy to be innovative. This prestaged the powerful social technology of "self-organizing systems." It seems that the region has a strong cultural predisposition for the application of both of these "new" approaches described above as the dominant global trends in today's rapidly changing institutions.

The people from Asia and the Pacific are vastly diverse, of course, but it would be useful to have corporations and governments engage in a regional dialogue to more systematically define the unique principles that have made the region a formidable player in the global economy. Americans are committed to a more extreme form of capitalism that is dynamic and creative but harsh. Europeans have developed a more socially oriented market system that is reasonably productive and supports the highest quality of life in the world. Can Asia and the Pacific embrace a model combining these two poles of entrepreneurial creativity and social harmony?

A large body of research suggests the two approaches can be unified into far more powerful economic systems. An honored scholarly tradition has studied alternative economic models operating around the globe and consistently finds them superior to conventional systems.[436] Furthermore, the absence of an improved, 21st century model of the large public corporation seems to be one of the greatest obstacles to a sustainable form of globalization. For lack of political initiative, no major nation has successfully moved these creative practices into the economic mainstream. An empty niche persists in the global economy for a synthesis that could be called "democratic enterprise," "markets with a human face," or "entrepreneurial community."

The challenges of adopting some type of hybrid economic system are enormous, but so are the potential gains. It is precisely such unresolved differences that drive growth of any type. Different energy levels are needed to power any mechanical engine, and price differences energize an economy. Likewise, synthesizing the powers of both entrepreneurship and community in corporations and the economy could unleash far greater financial wealth as well as tremendous social progress.

From this brief exploration of emerging technologies and their environmental implications, it should be obvious that there is no "silver bullet" waiting in the wings to solve all of humanity's economic or environmental problems. Any suggestion that technology will provide simple solutions is misleading and misguided. Almost all new technology needs to be treated with some skepticism on (i) how rapidly it will become mainstreamed in commercial markets, (ii) the ease of adoption in developing countries, and (iii) its contribution toward environmental and social improvement. The dual-edged sword characteristic of technology appears to be a generally applicable rule.

A change in mindset is needed to ensure that (i) research is devoted to the most promising technologies, (ii) inventors and innovators are rewarded for environmentally beneficial advances, (iii) companies are provided with incentives to develop such technologies, and (iv) barriers are removed from diffusion of the best technologies to developing countries. A broad coalition of stakeholders needs to work together to ensure that maximum pressure is applied to all decision makers to make choices in favor of environmentally beneficial technologies and to penalize choices that go in the opposite direction.

"Markets and technologies are merely tools that serve the goals, the ethics, and the time horizons of the society as a whole. If a society's goals are to exploit nature, enrich the elites, and ignore the long term, then that society will develop technologies and markets that destroy the environment, widen the gap between the rich and the poor, and optimize for short-term gains."[437] The need is to change the feedback structure or information links in our society so that a common set of ideas, goals, incentives, costs, and feedback all point in the same direction to a shared vision of sustainable development. "The trick is to choose the best (technology) for any given situation, in terms of both solving a particular problem and avoiding the creation of a whole new set of problems."[438]

We need to decide how to (i) increase expenditure on new environmental technology, infrastructure, goods, and services; (ii) help lagging countries and corporations to leapfrog over dirty, outdated technologies and policies; (iii) examine thoroughly the environmental and social implications of emerging technologies before they are introduced; and (iv) ensure that solid, traditional values that could underpin sustainability are not lost in the process of globalization. How do we ensure that business, governments, and civil society turn away from the currently dominant paradigm of economic growth at all costs and focus on patterns of development and technology application that will aid and abet a transition to a sustainable future rather than dreaming up new ways to consume the Earth's resources? Here too, the emerging technologies reviewed offer insights to a vision of companies that are making profits and protecting the planet.

CHAPTER 7

Facilitating the Move toward Sustainability

An underlying theme of this report is that the environmental future of the planet largely hinges on what happens in Asia and the Pacific over the next 50 years or so. Also, a sustainable future requires conscious efforts on the part of government, the private sector, and citizens to depart from past patterns. So, what are the key choices and decisions that need to be taken to create an atmosphere of policies and behaviors supporting sustainability? There clearly are initiatives that corporations can take that are internal to their own operations and entirely within their control. Some of these will be encouraged by incentives offered by governments, though this will require both economic and environmental policy reform. There also will be tremendous investment demands generated by these changes, and innovations in financial instruments will be needed to pay for new environmental infrastructure and other costs.

The conclusion is that assuring environmental performance can no longer be thought of as purely the realm of the public sector. Businesses in Asia and the Pacific have a big role to play with responsibility for environmental outcomes shared between the public and private spheres.

The first step that many corporations in this region need to take is simply to meet existing standards. Pressures emanating from a wide range of international and national sources will make it progressively harder for businesses to avoid compliance with environmental laws and regulations. The penalties exacted by traditional regulators and by communities and individuals emboldened by new information tools will make it increasingly difficult for environmental laggards to hide. Undoubtedly, the need for corporations to obtain a "social license" to operate will become ever more important.

Some of the needed changes will incur new costs for the private sector, but there also will be opportunities for savings from eco-efficiency gains as well as to enhance revenues through product differentiation. Some corporations from the region—mostly the larger ones—are already seeing the benefits of utilizing all or part of the "sustainability toolkit" described in this report. The majority of corporations, though, will be expected to begin responding to incentives created by new applications of economic instruments in environmental policies or to opportunities created by a reconfiguration of their relationships with government to accelerate adoption of new environmental management practices.

BALANCING INCENTIVES

It certainly makes sense for governments to make use of market-based environmental policies known to be effective at encouraging corporate innovation to meet pollution and natural resource management standards. The public sector also should encourage the uptake of voluntary tools that can take firms beyond compliance. In the process, it will prove beneficial to both public health and the sustainability of the environment to reassess those laws and regulations that have proven difficult to enforce with an eye toward enhanced policy effectiveness.

Market-based incentives such as penalties for pollution loads exceeding those determined to be consistent with the environment's assimilative capacity or tax breaks on investments in energy-saving technologies can induce changes in the behavior of firms. As suggested in AEO 2001, much of this will be focused on internalizing "market externalities" (ensuring that polluters pay for the damages they cause), "green" tax reform, and the elimination of perverse subsidies.

It is crucial that governments find the most effective means in their country settings for encouraging the adoption of sustainability tools and for furthering innovation. Fortunately, many of the region's largest corporations—especially those with international ties—already recognize the benefits of these tools. The more difficult problem is how to encourage similar practices by millions of SMEs. Supply chain pressures—and the "greening of the supply chain"—can potentially lead to substantial environmental performance improvements through links between MNCs and their Asian and Pacific suppliers. Multinationals appear increasingly to be requiring local suppliers and contractors to meet product and process standards. While product standards tend to be specific to the manufacturing sector, process standards are rapidly accepting ISO 14001 as the EMS template for certification of environmental responsibilities. Likewise, the GRI has emerged as best practice for environmental reporting. Demands on local suppliers to accept process standards as a cost of doing business with MNCs also are increasing accompanied by monitoring and auditing by reputation-sensitive international buyers.

A less common linkage between multinational firms and suppliers is technical collaboration. While the cost of meeting standards and submitting to monitoring may be seen as a substantial burden by some SMEs, MNCs can help to reduce this by providing hardware solutions (such as pollution abatement technologies) or guidance to SME management in relation to developing and implementing sustainability tools. There is some evidence that this is already happening, especially training for EMS development.

MNCs are not the only avenue for assisting SMEs with technical assistance on sustainability tools. If foreign firms are unwilling to be partners, then industry associations, national governments, and multilateral agencies can fill this role. In most parts of Asia and the Pacific, government agencies will probably be the best vehicles for providing such technical assistance on clean technologies and pollution prevention, for example, although in some countries, firms are more likely to be sensitive to the influence of their trade associations. There are already good examples of government-funded capacity-building programs for EMS in Malaysia, Singapore, and Sri Lanka. Experience has shown, however, that such programs must be firmly grounded in an understanding of applicable market forces and thoroughly blended with other complementary policy measures to be effective.

Governments and multilateral institutions can also assist with the difficult problem of how to deal with environmental management in very small firms and larger SMEs that are not involved in multinational supply chains. Dealing with such firms is difficult mainly because there are so many of them. While their individual environmental footprints may be quite small, the combined effect of millions of small firms can be just as damaging as that of a smaller number of large corporations. Several approaches to direct interventions hold promise for this region. These include EMS tailored to the special needs of SMEs, government-sponsored and field-based "extension" services to provide technical guidance, and eco-friendly industrial estates.

There are examples from developed countries of customized EMS that have been successfully trialed with SMEs. These involve simple "template" systems that specifically address the concerns of small firms about the cost, time, and documentation associated with developing and implementing full EMS. These simplified systems would rely on a checklist approach rather than on comprehensive record keeping, thereby acting as a kind of self-audit backed by industry-specific environmental guidelines.

Another approach that might be taken by national governments and multilateral institutions to assist very small firms is to apply the self-help model of agricultural extension programs to the problems of environmental management. There are many examples in Asia and the Pacific of farmers organizing to teach other farmers about improving productivity. The agricultural extension training and visit scheme adopted in many developing countries may also be worth emulating.

A third approach is the establishment of industrial zones in which the tools are made mandatory. This will work best in industrial estates, especially where products are bound for export to developed-country supply chains. Both the PRC and Thailand have been experimenting with this idea, and the PRC recently announced that nine economic development zones, five "high-tech" development zones, and four scenery spots have been approved as national demonstration areas in which ISO 14001 certification will be a prerequisite for business operation. Such schemes also lend themselves to the provision

Box 8: Small and Medium-Sized Enterprises and Environmental Compliance

As many governments around Asia and the Pacific have found, trying to get small and medium enterprises (SMEs) to clean up is a difficult prospect. For a number of reasons, conventional regulatory measures are not effective with this group. First, they lack capital, and often cannot afford cleaner production technologies or end-of-pipe measures. Second, many of them lack environmental knowledge and awareness (some are not even fully aware of their harmful environmental impacts). Third, most SMEs lack exposure to public scrutiny and adverse publicity. Meanwhile, the sheer number of such enterprises means that understaffed and underfunded regulatory regimes cannot hope to effectively reach and regulate the group (a problem, it should be noted, that is also experienced in developed countries). And even if enforcement were stronger, countries would risk putting people out of work and shutting down local businesses if they clamp down heavily on pollution.

Part of the answer may lie in trying to get SMEs to comply with voluntary standards, but even here there are problems. The cost of benchmarking to world standards for an SME can be forbidding. To achieve ISO-14001 status, for example, most companies need to hire environmental consultants to guide them through the process. These consultants can cost between US$30,000 and US$60,000 per company certification, depending on circumstances. An ISO-14001 audit usually takes three days, followed by a "surveillance audit" at a farther cost of US$6,000 to US$12,000 per year. Additionally, another audit is required when the certificates expire after three years.

If an SME wants to go further, the ongoing advisory costs for a comprehensive reporting program can be even more prohibitive. The lowest charges for verifying these reports can easily be twice the cost of actually producing them. And if a company tries a lower cost option, such as using an NGO, it risks not getting its environmental and social reports verified, which defeats the purpose of the exercise. Thus, those SMEs that are considering certification must weigh the considerable costs of meeting international standards with the potential benefits.

Since many SMEs lack awareness and knowledge about potential cost-saving management practices, many governments and donor programs have focused on sharing information and promoting voluntary measures-often working through industry associations. As it is quite common for similar SMEs to geographically cluster, some progress has been made by retrofitting common pollution collection and treatment systems or by relocating SMEs to industrial estates providing such services. With respect to financial constraints, special funds have been established through commercial banks in several countries, namely, Sri Lanka and India. These measures clearly demonstrate that SMEs can improve their environmental performance if they are motivated to try, and are given access to cleaner production assessment methods as well as financing and technologies for environmental management.

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of common waste treatment facilities, and the relocation to industrial estates of SMEs processing similar products (notably the tannery and textile industries) has been undertaken in Indonesia, Pakistan, and Sri Lanka.

ENVIRONMENTAL REGULATORY REFORM

This report argues that the traditional options of command-and-control regulation will not be enough to meet the sustainability challenges provided by the region's continued rapid economic expansion. A recurring theme is that more rapid progress is needed with the application of market-based incentives to encourage private innovation. A full conversion from the current system will only be possible if accompanying reforms are made in public environmental policy. The combination of diminishing government resources and an explosion in industry self-management initiatives is now leading to a reconfiguration of regulatory approaches. This is strongly evident in developed countries, though it appears to have happened largely by policy evolution rather than by design. While there are hesitant signs of such reconfiguration beginning in Asia and the Pacific, most environmental policy in the region remains firmly centered on the command-and-control model rather than on the use of market-based incentives or voluntary measures involving public-private partnerships. Though even the developed world has less than a decade's experience with this new mix of policies, some important lessons are emerging of direct relevance to region.

Serious attention needs to be paid to the wider application of voluntary environmental instruments. Various propositions have been made in recent years about how the supporting policy frameworks for introducing voluntary initiatives might best be designed. The most useful of these suggest that they should build upon a careful linkage between the most important drivers of voluntary corporate initiatives: (i) cost reduction, (ii) desire to avoid regulatory action, (iii) concern about damage to public image, (iv) expectation of competitive advantage, and (v) pressure from stakeholders.

In this new mode of "co-regulation," there is a genuine sharing of responsibility and authority for administering regulation between governments and industry. The proper role of government becomes setting clear but broad targets for important environmental outcomes or conditions and then stepping back to allow firms wide-ranging freedom to find the most cost-effective methods by which to comply. A good metaphor for this new approach is "steering not rowing." It should also be noted that the introduction of voluntary measures often has faced considerable skepticism and outright opposition from environmental advocacy groups who see these approaches as too soft on polluters and too willing to strike compromises with private firms in order to achieve environmental goals.

Evaluations of developed country use of voluntary environmental instruments have begun to indicate some minimum preconditions for success. In general, it seems that governments need to (i) present a credible threat of regulation should self-policing fail; (ii) maintain capacity for auditing and monitoring; (iii) establish a system whereby offenders can be made personally liable if they fail to comply; and (iv) cultivate an active civil society that can provide indirect oversight and monitoring support to regulatory authorities.

Some regulators in the region are interested in voluntary environmental instruments precisely because they offer policy alternatives that require less administrative structure and rely more on the private sector itself for monitoring and choice of environmental management measures. While meeting the full preconditions would provide the ideal conditions to support a co-regulation approach, there is enough evidence from Asia and the Pacific to indicate that significant progress is possible even with only some of the preconditions in place. For example, despite weak or nonexistent formal regulation, there are many clean industrial plants in the region. Analysis done under the World Bank's New Ideas in Pollution Regulation project has identified examples in South and South East Asia where factories are less polluting than in the past and where total emissions are falling despite strong industrial growth.

The role of regulation as a credible threat may become less important over time in the Asian and Pacific context as the effectiveness of an increasingly active civil society grows. The preconditions mentioned also may not need to be present where there are powerful self-interests at stake. Such incentives, as previously described, could include (i) protection of reputation; (ii) enhanced market opportunities; (iii) requirements imposed by financial institutions or foreign partners; and/or (iv) the existence of environmental improvements that directly result in cost savings.

While co-regulation and associated voluntary environmental policy instruments may significantly improve corporate environmental performance, this should never be a rationale for abandoning standards and supporting regulations. Governments in Asia and the Pacific should continue to develop and refine their formal regulatory structures and enforcement capacities as complements to these other policy approaches. Furthermore, some environmental goals, such as the control of hazardous and toxic substances, may continue to be best accomplished through strict regulatory approaches. For certain countries where capacity is very weak, informal regulatory approaches could be a short-term strategy for halting environmental decline, until a full blend of formal regulatory structures, market-based incentives, and voluntary measures is put in place.

In some countries of the region, environmental law and policy already allows for use of voluntary agreements. Indonesia, for example, has experimented with the PROPER system of publicly disclosing rankings of company environmental performance according to a five-point scale, and then working with the low performers to adjust their behavior under threat of sanction and public disgrace. Viet Nam is experimenting with a similar approach. Other measures could include encouraging the establishment of units within industry associations or leading financial institutions that pay attention to environmental performance, perhaps giving them shared responsibility for the development and implementation of voluntary agreements. This has been used in Sri Lanka with some limited success.

Voluntary mechanisms rely heavily on the free availability of information to all stakeholders, though there are still few locations in this region where accurate and timely environmental information is made available to stakeholders by the private sector. Given what seems to be the growing importance of co-regulation, including information-based policies, governments will find benefit in passing legislation requiring the regular publication of environmental data (taking into account proprietary concerns). Examples include "right-to-know" laws, "green rating" schemes (such as Indonesia's PROPER), compulsory annual reporting on corporate environmental performance, and the publication of national registries of voluntary initiatives.

CONCLUSION

The impetus for this report is a sense of urgency. Our planet is facing unprecedented levels of environmental strain, and much of this is the result of the extraordinary economic growth recently witnessed in Asia and the Pacific. The future of humankind and the planet will depend in large measure on how successful the environmental policies and practices are in this part of the world.

The business community's actions hold the key to whether further rapid economic growth in this region can be achieved without undermining the basis for health and prosperity. Times are changing, and the private

sector can expect to face considerably more oversight of its environmental performance by governments, communities, advocacy groups, financial institutions, shareholders, and consumers. These changes are likely to bring higher costs in many cases, but there also will be opportunities for savings and even enhanced revenue generation through eco-efficiency gains and product differentiation. The tools to identify such opportunities are readily available and center on incorporating into business practice far better systems for measuring inputs, outputs, and associated environmental impacts. Working with these forces rather than fighting against them, hiding from them, or paying them off, companies will find ways to help shape the environmental laws that affect them so that they encourage innovation and creative solutions to pollution or natural resource degradation challenges.

National governments need to recognize the growing citizen and consumer demands for better environmental quality and management. This can be especially important for export competitiveness given the rising expectations imposed by importers. Environmental policies need to be reviewed and improved in light of these developments with an emphasis on inducing efficient and innovative responses to problems of waste management and natural resource degradation. New market-based and voluntary policy measures can be used to shape corporate behavior while also creating the conditions needed to engage with the private sector in meeting the rising demands for environmental infrastructure across the region.

As called for in AEO 2001, governments also must do a better job of integrating environmental concerns into both macroeconomic and sector policies and must conduct an active search for new means to finance environmental infrastructure, especially to identify appropriate areas where the private sector can provide services. They can do this with the assurance that while some jobs will be lost in polluting industries, this is likely to be offset by new economic opportunities created by mitigation and clean-up efforts, by the construction of environmental infrastructure, and by a wide range of new jobs in related service industries supporting such activities.

Development agencies need to recognize the direct links between environmental quality problems and constraints to growth, investment, and poverty alleviation. Past policy advice needs to be informed by these important new trends to take more positive attitudes toward the private sector's role in addressing the environmental consequences of development. There are enormous investment demands, and the public sector alone cannot hope to provide the capital and expertise needed to meet them. New financial instruments will be required that tap into private capital and involve closer public-private cooperation in planning and implementing environmental infrastructure and other investments while continuing to rely on market forces.

Wise companies will anticipate these changes and find ways to shelter themselves from the potential for increased cost and risk by taking advantage of opportunities to raise their competitiveness through operational innovations and product differentiation. Those who are slow to act will find themselves at odds with their governments, communities, and shareholders while also losing market share for their products or services. A new definition of "business as usual" is emerging in which gross neglect of the environment will no longer be tolerated, with both large and small companies expected to exhibit environmental responsibility. Those who step up to this challenge will prosper while those who do not will increasingly find themselves to be out of step with their peers and society at large and their ability to operate threatened by competition and by the heavy scrutiny of governments, shareholders, consumers, and the communities in which they operate. ■

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Chapter 1

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Chapter 2

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Chapter 3

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99 This conclusion is reached by Afsah et al **[ref. Chapter 3:89]**.
100 Sani, Rasio Ridho. 2005. Achieving Compliance Through the PROPER Program. Presentation at the Asian Environmental Compliance and Enforcement Network Regional Workshop, ADB, Manila, 3 August.
101 It should also be noted that conventional National Economic Development Plans, which are common in Asia and are often produced at a regular 5-year basis, sometimes include sections dealing with environmental issues.
102 World Bank. 1995. *National Environmental Strategies—Learning from Experience*. Washington, DC.
103 Immerzeel-Brand, Ellis. 2002. Assessing the Performance of Negotiated Environmental Agreements in the Netherlands. In *Voluntary Environmental Agreements: Process, Practice, and Future Use*. Edited by Patrick ten Brink. Sheffield, UK: Greenleaf Publishing.
104 Gunningham, Neil, and Darren Sinclair. 2002. *Leaders and Laggards: Next Generation Environmental Regulation*. Sheffield, UK: Greenleaf Publishing.
105 www.svm-pact.nl
106 Hanks, Jonathan. 2002. A Role for Negotiated Environmental Agreements in Developing Countries? In *Voluntary Environmental Agreements: Process, Practice, and Future Use*. Edited by Patrick ten Brink. Sheffield, UK: Greenleaf Publishing.
107 United Nations Department for Economic and Social Affairs (UNDESA). 2002. *National Implementation of Agenda 21: A Report*. New York: United Nations Publications.
108 Ge, Chazhong, Jintian Yang, Yang Tong, Kai Tong and Dong Cao. 2003. *Environmental Enforcement and Compliance Indicators in China. Chinese Academy for Environmental Planning*. Proceedings of International Network of Environmental Compliance and Enforcement, OECD Workshop on Environmental Compliance and Enforcement Indicators, Paris, France, 3-4 November.
109 The original 500 recognized firms, however, were reduced to 183 on reappraisal in 1989–1990. Enforcement also remains weak, polluters are allowed to retain the pollution levies (ostensibly to invest in improved pollution-control equipment), and the environment continues to degrade.
110 http://www.env.go.jp/en/pol/agenda/
111 Government of Japan. 2002. *Japan National Assessment for WSSD*. www.rrcap.unep.org/wssd/documents/japanation.pdf.
112 Speth, James Gustave. 2004. *Red Sky at Morning: America and the Crisis of the Global Environment.* New Haven: Yale University Press.
113 Speth, ibid
114 There are approximately 200 environmental treaties in existence. A comprehensive source of information on environmental treaties is: http://sedac.ciesin.columbia.edu/entri/index.jsp
115 Shaw, Malcolm. 1997. *International Law*. Cambridge, UK: Cambridge University Press
116 This Protocol had not entered into force at the time of writing.
117 For more details about the implications of EIA for proponents and regulators in developing countries, see Annandale 2001 **[ref. Chapter 3:93]**.
118 For a discussion on strategic environmental assessment, see Annandale, David, John Bailey, Ely Ouano, Warren Evans, and Peter King. 2001. The Potential Role of Strategic Environmental Assessment in the Activities of Multilateral Development Banks. *Environmental Impact Assessment Review* 21 (5): 407–429. For an outline of the developing area of sustainability assessment, see Pope, Jenny, David Annandale, and Angus Morrison-Saunders. 2004. Conceptualising Sustainability Assessment. *Environmental Impact Assessment Review* 24 (6): 595–616.
119 UNDESA **[ref. Chapter 3:107]** documented progress since the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. For Asia and the Pacific, about half of the 44 nations reported that they had substantially implemented parts of Agenda 21. The overall impression of the report was that more participatory approaches involving key stakeholders and better integration with economic incentives were needed in the region.
120 UNESCAP 2003a. *Promoting the Millennium Development Goals in Asia and the Pacific: Meeting the Challenges of Poverty Reduction.* New York: United Nations Publication
121 http://www.johannesburgsummit.org
122 For an amplification of this argument, see Speth **[ref. Chapter 3:112]**.
123 The International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights.
124 Commission on Environmental Law of the World Conservation Union in cooperation with International Council of Environmental Law. 2004. *Draft International Covenant on Environment and Development*. Gland, Switzerland: IUCN.
125 See Speth **[ref. Chapter 3:112]**. From someone who was at the heart of these negotiations for many years, it is discouraging to read how little Speth believes he and his colleagues achieved through the multilateral environmental agreements.
126 UNESCAP 2003b. *Regional Follow-Up to the World Summit on Sustainable Development in Asia and the Pacific.* New York: United Nations Publication.
127 (i) UNEP. 2000. *Asia-Pacific Environment Outlook 2*. Nairobi: United Nations Publication. (ii) UNESCAP. 2000. *State of Environment in Asia and the Pacific 2000.* New York: United Nations Publication.

128 "Implementation of Agenda 21 and the outcomes of the Summit should be effectively pursued at the regional and subregional levels, through the regional commissions and other regional and subregional institutions and bodies" (JPOI, para. 158). Inter alia, regional organizations are called upon to "facilitate and promote a balanced integration of the economic, social and environmental dimensions of sustainable development into the work of regional, subregional and other bodies, for example by facilitating and strengthening the exchange of experiences, including national experience, best practices, case studies and partnership experience related to the implementation of Agenda 21" (JPOI, para. 160).

129 See UNESCAP 2003b. **[ref. Chapter 3:126]**

130 As of November 2004, Indonesia, Cambodia, and the Philippines had not yet ratified the agreement (http://www.haze-online.or.id/).

131 UN Economic and Social Council. 2004. *Partnerships for Sustainable Development*. Report of the Secretary-General. Commission on Sustainable Development. Twelfth Session, 14–30 April.

132 The database of more than 260 partnerships is at http://webapps01.un.org/dsd/partnerships/public/.

133 Descriptions of voluntary agreements that have been adopted around the world can be found in: (i) OECD 1999. *Voluntary Approaches for Environmental Policy: An Assessment*. Paris: OECD Publications; (ii) European Environment Agency (EEA). 1997. *Environmental Agreements: Environmental Effectiveness*. Environmental Issues Series 3 (1–2). Copenhagen; (iii) OECD. 2003. *Voluntary Approaches for Environmental Policy: Effectiveness, Efficiency, and Usage in Policy Mixes*. Paris: OECD Publications; and iv) Moffet, John., and Francois Bregha. 1999. An Overview of Issues with Respect to Voluntary Environmental Agreements. *Journal of Environmental Law and Practice* 8 (1): 63–94.

134 Mazurek, Janice. 2002. Government-Sponsored Voluntary Programs for Firms: An Initial Survey. In *New Tools for Environmental Protection: Education, Information, and Voluntary Measures*. Edited by Thomas Dietz and Paul Stern. Washington, D.C.: National Academy Press.

135 Market forces appear to focus on the cost savings that can be gained from increased flexibility relative to command-and-control regulation, combined with gains from reduced confrontation.

136 For research on the topic of drivers of voluntary agreements, see Annandale and Taplin **[ref. Chapter 1:25]** and Darnall **[ref. Chapter 1:25]**.

137 Reasons for changes in the world order of environmental policymaking are explained by Eckerberg and Joas. [Eckerberg, Katarina., and Marko Joas. 2004. Multi-Level Environmental Governance: A Concept Under Stress? *Local Environment* 9 (5): 405–412.]

138 Alberini and Segerson (2002) suggest the following:
a. bilateral agreement between a regulatory agency and a polluter (or group of polluters)
b. voluntary government program under which the regulatory agency unilaterally determines both the rewards and obligations from participation, as well as the eligibility criteria. The regulator designs the program, and then seeks participation given the terms it specifies. [Alberini, Anna, and Kathleen Segerson. 2002. Assessing Voluntary Programs to Improve Environmental Quality. *Environmental & Resource Economics* 22:157–184.]
OECD 1999 **[ref. Chapter 3:133]** suggests:
a. Private agreements between polluters and the polluted. Contracts between a firm (or group of firms) and those who are harmed by its emissions.
b. Environmental agreements negotiated between industry and public authorities.
c. Voluntary programs developed by public authorities, to which individual firms are invited to participate.
Mazurek **[ref. Chapter 3:134]** offers:
a. Public voluntary: non-mandatory rules developed by a government body.
b. Unilateral commitments: refer to programs established by industry to encourage firms to achieve environmental improvements
c. Negotiated agreements: contracts between public authorities and industry. In contract to public voluntary efforts, negotiated agreements contain specific targets and are legally binding.

139 Stratos Inc. 2002. *Industry Codes of Practice and Other Voluntary Initiatives: Their Application to the Mining and Metals Sector*. Report for the Mining, Minerals and Sustainable Development Project of the International Institute for Environment and Development.

140 Adapted from Stratos 2002, ibid.

141 For examples of industry association Codes of Practice in the US, see Nash, Jennifer. 2002. Industry Codes of Practice. In *New Tools for Environmental Protection: Education, Information, and Voluntary Measures*. Edited by Thomas Dietz and Paul Stern. Washington, DC: National Academy Press.

142 http://www.minerals.org.au/environment/code

143 http://www.icca-chem.org/rcreport

144 There is a substantial literature that describes and evaluates Responsible Care. Examples include (i) Prakash, Aseem. 2000b. Responsible Care: An Assessment. *Business and Society* 39 (2): 183–209. (ii) King, Andrew, and Michael Lenox. 2000. Industry Self-Regulation Without Sanctions: The Chemical Industry's Responsible Care Program. *Academy of Management Journal* 43 (4): 698–716. (iii) Howard, Jennifer, Jennifer Nash, and John Ehrenfeld. 2000. Standard or Smokescreen? Implementation of a Voluntary Environmental Code. *California Management Review* 42 (2): 63–82.

145 http://www.responsiblecare-us.com/accountability.asp

146 Tahmina, Qurratul Ain, and Philip Gain. 2002. *A Guide to NGO-Business Partnerships*. Dhaka: Society for Environment and Human Development. Many of these relationships focus on certification and eco-labeling, and is dealt with in more detail in Chapter 4. An example is the Better Banana Project (http://www.bsdglobal.com/viewcasestudy.asp?id=109). See also: (i) Hartman, Cathy, Edwin Stafford, and Michael Jay Polonsky. 1999. Green Alliances: Environmental Groups as Strategic Bridges to Other Stakeholders. In *Greener Marketing: A Global Perspective on Greening Marketing Practice*. Edited by Martin Charter and Michael Jay Polonsky. Sheffield, UK: Greenleaf Publishing and (ii) Plante, Christopher, and Jem Bendell. 1998. The Art of Collaboration: Lessons from Emerging Environmental Business—NGO Partnerships in Asia. *Greener Management International* 24: 91–104.

147 See Gunningham and Sinclair **[ref. Chapter 3:104]** and Mazurek **[ref. Chapter 3:134]**

148 USEPA set a goal of reducing the total amount of these chemicals released into the environment and transferred off-site by 33% by the end of 1992 and by 50% by the end of 1995. The goal was reached by 1994.

149 Mazurek **[ref. Chapter 3:134]** lists 31 public voluntary programs that were implemented during the 1990s in the US.

150 Chidiak, Martina and Matthieu Glachant, M. 2000. *The French Country Study: Case Studies in the Sectors of Packaging Glass and Aluminum. Voluntary Agreements—Implementation and Efficiency.* www.akf.dk/VAIE

151 The Australian Greenhouse Challenge—launched in 1995–is a joint voluntary initiative between the national government and industry to abate greenhouse gas emissions. Participating organizations sign agreements with the government that provide a framework for undertaking and reporting on actions to abate emissions. More details can be found at: http://www.greenhouse.gov.au/challenge/

152 UNEP has a good description of negotiated agreements. [UNEP. 2000. *Voluntary Initiatives: Current Status, Lessons Learnt and Next Steps*.]

153 The objectives of the Australian Packaging Covenant are: (i) to establish a framework based on the principle of shared responsibility for the effective lifecycle management of packaging and paper products including their recovery and utilization; (ii) establish a collaborative approach to ensure that the management of packaging and paper throughout its lifecycle and the implementation of collection systems including curbside recycling schemes, produces real and sustainable environmental benefits in a cost effective manner; and (iii) establish a forum for regular consultation and discussion of issues and problems affecting the recovery, utilization and disposal of used packaging and paper, including costs. More information can be found at: http://www.deh.gov.au/industry/waste/covenant/anzecc/

154 Gunningham and Sinclair **[ref. Chapter 3:104]** describe the Dutch environmental covenant system as an "unusual hybrid" that defies formal classification. This is because the covenants address collective and sector-wide environmental issues and are legally binding on individual enterprises through the permit system. This makes them intimately linked to mainstream command and control. We deal with the Dutch covenant approach earlier in the chapter because it grows out of a National Environmental Policy.

155 Environment Canada. 2001. *Policy Framework for Environmental Performance Agreements*. Ottawa. See also UNEP, 2000 **[ref. Chapter 3:152]**.

156 See Gunningham and Sinclair **[ref. Chapter 3:104]**

157 Tsutsumi, Rie. 2002. Successful Application of Environmental Agreements in Local Communities: Perspectives from Environment and Pollution Control Agreements in Japan. In *Voluntary Environmental Agreements: Process, Practice, and Future Use*. Edited by Patrick ten Brink. Sheffield: Greenleaf Publishing.

158 See OECD 2003 **[ref. Chapter 3:133]**

159 See Hanks **[ref. Chapter 3:106]**

160 See Hanks **[ref. Chapter 3:106]**

161 These arguments are well put in Alberini and Segerson **[ref. Chapter 3:138]** and Gunningham and Sinclair **[ref. Chapter 3:104]**.

162 See: (i) OECD 2003 **[ref. Chapter 3:133]**; (ii) Alberini and Segerson **[ref. Chapter 3:138]**; (iii) Nash **[ref. Chapter 3:141]**; (iv) Harrison, Kathryn. 2002. Challenges in Evaluating Voluntary Environmental Programs. In *New Tools for Environmental Protection: Education, Information, and Voluntary Measures*. Committee on the Human Dimensions of Global Change. Edited by Thomas Dietz and Paul Stern. Washington, D.C.: National Academy Press; and (v) Mazurek **[ref. Chapter 3:134]**.

163 See Harrison **[ref. Chapter 3:162]**

164 The "few cases" quoted are the Dutch environmental covenants and the Japanese EPCAs. See 1999 and 2003 OECD reports **[ref. Chapter 3:133].**

165 There is agreement on these points from (i) Gunningham and Sinclair **[ref Chapter 3:104]**; (ii) OECD 1999 **[ref. Chapter 3:133]**; (iii) OECD 2003 **[ref. Chapter 3:133]**; (iv) Hanks **[ref. Chapter 3:106]**; and (v) Alberini and Segerson **[ref. Chapter 3:138]**. Free-riding is a situation where firms do not choose to join a voluntary agreement but reap the benefits of a sectoral agreement where active participants do improve their performance. Regulatory capture theorists suggest that there are intense pressures for regulatory agencies to acquiesce in the negotiation of targets, the result being conditions that are unduly favorable to industry and contrary to the public interest.

166 See OECD 1999 **[ref. Chapter 3:133]**

167 See National Research Council 2002 **[ref. Chapter 1:23]**

168 Krut, Riva, and Harris Gleckman, H. 1998. *ISO 14001: A Missed Opportunity for Sustainable Global Industrial Development*. London: Earthscan Publications Ltd. This concept has been recognized by agencies such as the USEPA, which is soon to begin a project with the Chinese Government (through SEPA) to promote voluntary environmental initiatives through trade associations.

169 For an extensive investigation into whether developing countries set inefficient environmental standards to attract foreign investment, see: (i) Neumayer, Eric. 2001. *Greening Trade and Investment: Environmental Protection Without Protectionism*. London, UK: Earthscan Publications Ltd. and (ii) Jenkins, Rhys Owen, Jonathan Barton, Anthony Bartzokas, Jan Hesselberg, and Hege Merete Knutsen. 2002. *Environmental Regulation in the New Global Economy: The Impact on Industry and Competitiveness*. Cheltenham, UK: Edward Elgar.

170 See Hanks **[ref. Chapter 3:106]**

171 Davy, Aidan. 1997. Environmental Management Systems: ISO 14001 Issues for Developing Countries. In *ISO 14001 and Beyond: Environmental Management Systems for the Real World*. Edited by Christopher Sheldon. Sheffield, UK: Greenleaf Publishing. Davy points out that the numbers of developing country participants are not necessarily an accurate reflection of actual influence. In his view, this is due to the origins of ISO 14001 being rooted in EMS developments in Western Europe, and the poorer resourcing of developing country delegates.

172 Significant detail can be found at: http://www.iso14000.com

173 UNDP. 1996. *ISO 14000 Environmental Management Standard and Implications for Exporters to Developed Markets*. New York: UNDP Private Sector Development Program.

174 See Krut and Gleckman **[ref. Chapter 3:168]**

Chapter 4

175 Sullivan, Rory, and Hugh Wyndham. 2000. *Effective Environmental Management: Principles and Case Studies*. Sydney: Allen and Unwin
176 Uzumeri, Mustafa. 1997. ISO 9000 and Other Metastandards: Principles for Management Practice? *Academy of Management Executive* 11 (1): 21–36.
177 Krut and Gleckman **[ref. Chapter 3:168]** provide a detailed explanation of the differences between European Eco-Management and Audit Scheme and ISO 14001. They state that: "In process and content, the differences between the two standards lie precisely in the areas crucial to sustainable development: public access to information, legal environmental proceedings, assurances of regulatory compliance, and environmental performance assurances and improvements."
178 North American Commission for Environmental Cooperation. 2000. *Improving Environmental Performance and Compliance: 10 Elements of Effective Environmental Management Systems.* http://www.cec.org This Guidance Document concludes that "an EMS that follows through on a commitment to continuous improvement allows the organization using it to achieve better performance levels than those required by government regulation."
179 Adapted from: Hortensius, Dick, and Mark Barthel. 1997. Beyond 14001: An Introduction to the ISO 14001 Series. In *ISO 14001 and Beyond: Environmental Management Systems for the Real World*. Edited by Christopher Sheldon. Sheffield, UK: Greenleaf Publishing.
180 This critique has been most forcefully put by Krut and Gleckman **[ref. Chapter 3:168]**.
181 Christmann, Petra, and Glen Taylor. 2001. Globalization and the Environment: Determinants of Firm Self-Regulation in China. *Journal of International Business* Studies 32 (3): 439.
182 Potoski, Matthew, and Aseem Prakash. 2004. Regulatory Convergence in Nongovernmental Regimes? Cross-National Adoption of ISO 14001 Certifications. *Journal of Politics* 66 (3): 885–905.
183 Montabon, Frank, Steve Melnyk, Robert Sroufe, and Roger Calantone. 2000. ISO 14001: Assessing Its Perceived Impact on Corporate Performance. *Journal of Supply Chain Management* 36 (2): 4–16.
184 Annandale, David, Angus Morrison-Saunders, and George Bouma. 2004. The Impact of Voluntary Environmental Protection Instruments on Company Environmental Performance. *Business Strategy and the Environment* 13: 1–12.
185 See Dasgupta et al **[ref. Chapter 2:91]**
186 See Annandale et al **[ref. Chapter 4:184]**
187 Heemskerk, Bert, Pasquale Pistoria, and Martin Sciicluna. 2002. *Sustainable Development Reporting—Striking the Balance*. Geneva: WBCSD.
188 Ibid.
189 Korean Environment Institute. 2002. Air Pollution in the Megacities of Asia: Stage 1.
190 Good examples of the latter are provided in Jones, Kathryn and Tony Alabaster. 1999. Critical Analysis of Corporate Environmental Reporting Scoring Systems. *Journal of Environmental Assessment Policy and Management* 1(1): 27–60.
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192 European Environment Agency. 2001. *Environmental Benchmarking for Local Authorities: From Concept to Practice*. Copenhagen.
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197 Evans, David, and Stuart Ross. 1998. The Role of Life Cycle Assessment in Australia. *Australian Journal of Environmental Management* 5: 137–145.
198 Rebitzer, Gerald, Tomas Ekvall, R. Frischeknecht, David Hunkeler, Greg Norris, Tomas Rydberg, Wulf Peter Schmidt, Sangwon Suh, B.P. Weidma, and David Pennington. 2004. Life Cycle Assessment Part 1: Framework, Goal and Scope Definition, Inventory Analysis, and Applications. *Environment International* 30:701–720.
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201 http://www.iso.org/iso/en/prods-services/otherpubs/iso14000/application.pdf
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204 http://www.fefco.org
205 http://www.nidi.org
206 http://www.worldsteel.org/env_lca.php
207 See Rebitzer et. al. **[ref. Chapter 4:198]**
208 Pennington, David W., José Potting, Göran Finnveden, Erwin Lindeijer, Olivier Jolliet, Tomas Rydberg, and Gerald Rebitzer. 2004. Life Cycle Assessment Part 2: Current Impact Assessment Practice. *Environment International* 30: 721–739.
209 See: (i) Rebitzer et al **[ref. Chapter 4:198]**; (ii) Lewis and Demmers **[ref. Chapter 4:196]**; Evans and Ross **[ref. Chapter 4:197]**
210 See Rebitzer et al **[ref. Chapter 4:198]**
211 Hunkeler, David, Konrad Saur, Gerald Rebitzer, Matthias Finkbeiner, Wulf Peter Schmidt, and Allan Astrup Jensen. 2004. *Life Cycle Management Report of the SETAC Working Group on LCM*. Pensacola, USA: SETAC.
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213 More information can be found on the website of the Japan Environmental Management Association for Industry (http://www.jemai.or.jp/english/lca/project.cfm).

214 Zakaria, Zulina, Mohd Hassan, and Muhamad Awang. 1999. Current Status and Needs for Life Cycle Assessment Development in Asian-Pacific Regions. *International Journal of LCA* 4 (4): 191–194.
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217 See Zakaria et al **[ref. Chapter 4:214]**
218 Sometimes shortened to "environmental accounting," though because this could create confusion with environmental income accounting to calculate "green gross domestic product" and other macroeconomic indicators of national environmental performance, this report will use EMA throughout.
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221 http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm
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Chapter 5

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232 http://www.recyclingtoday.com/news/news.asp?ID=6948
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235 Institute for Local Self-Reliance. 2000. Wasting and Recycling in Metropolitan Manila, Philippines. (http://www.greenpeacesoutheastasia.org). The Solid Waste Management Act 2000 mandates "zero waste management" as a national policy and requires local government units to recycle 25% of waste collected.
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242 Quote from Christian Kornevall from ABB appearing in Walking the Talk, the Business Case for Sustainable Development.
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255 These include tenuous ecological and socioeconomic conditions, uncertain or disputed land tenure, social and political conflicts concerning forest use, lack of financial and human resources, and institutional weaknesses.
256 *New Scientist*. 2003. Marine Stewardship Council Under Fire. 17, May, Vol 178, Issue 2395. http://www.eurocbc.org/ns_vol178_iss2395_p3_p1of3__17may2003page1025.html
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261 Environment Business International is a US-based private research and publishing firm focused on the environmental industry.
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263 See ECOTEC **[ref. Chapter 5:259]**
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277 Mindbranch. 2004. Introduction to Renewable Bulk Power Systems: Technologies, Markets, Regulations, Legislation, Incentives, Carbon Funds and Forecasts. http://www.mindbranch.com/products/R2-789.html
278 Ibid.
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280 See Mindbranch **[ref. Chapter 5:277]**
281 Bhattacharya, S.C. 2002. Biomass Energy in Asia: A Review of Status, Technologies and Policies in Asia. *Energy for Sustainable Development VI* (No. 3): 5–10.
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internal combustion engine." Exxon Mobil is developing auto fuel cells, Shell and BP have formed hydrogen divisions, and Texaco is working on storage. (*Futurist*. 2002. A Hybrid Future. Jan-Feb.) Ballard, the world's leading maker of fuel cells is planning to reduce costs from $2000/kw to $50/kw by mass producing 300,000 fuel cells in 2005. (*BusinessWeek.* 2000. How Hybrids Work. 8 May.) The US has committed $1.7 billion to support hydrogen research, the EU is investing $2 billion, and Japan $2 billion. Iceland is building the world's first hydrogen economy. PRC is hungry for energy, and many think it will take the lead by committing to fuel cell development. (*Toronto Star.* 2004. 20 Sep.) The California Fuel Cell Partnership, which includes major carmakers and energy firms, plans to place 300 fuel cell cars into demonstration tests and to build fueling stations every 20 miles on major highways. (*Fleet Owner*. 2004. Come to the Fair. May.) Pacific Northwest National Laboratory is developing an under-the-hood reformer that produces hydrogen from gas on demand. Further, the process produces twice the energy output than the original gas. (*BusinessWeek.* 2004. Vapor and Steam Beat Gasoline. 17 May.)

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340 Sao Paulo, Brazil, is home to more than 500 private helicopters used to commute executives to work in 15 minutes. (*Forbes* 2002. Copter Crazy. 13 May.) The Robinson R22 is the world's most popular helicopter, selling at $150,000 and carrying 2 passengers. More than 3,000 were sold as of 2001. Honda is developing a small cost-efficient air taxi designed to ferry 4–5 people between airports, and GE is building the jet engine. (*BusinessWeek.* 2004. Gotta Fly to the Office. 13 Sep.) Eclipse Aviation has 2,100 orders for its two-engine, five-passenger jet selling for $1 million, one-fourth the cost of a corporate jet. Cessna and Adam Aircraft are building similar "personal jets," due out in 2007. (*Newsweek.* 2003. A Taxicab at 30,000 Feet. 6 Oct.) Moller International is building a "Skycar" that travels at 350 mph and gets 15 mpg fuel efficiency. Global positioning systems and automatic pilot provide hands-free computer controlled travel. (*Herman Group*. 2001. Fly Your Car. 3 Jan.)

341 Mitsui OSK Lines Highlights for 2004. www.MOL.co.jp

342 *Computerworld*. 2003. Customs Will Fine Shippers. 23 Jan.

343 *New Scientist*. 2001. Rising Tide of Micro-Plastics. 20 Jan.

344 http://www.planktos.com

345 Other telematic technologies considered were combined on-board emissions and engine management; multimodal traveler information/trip planning; dynamic route planning; in-vehicle traffic information; electronic tolling; navigation; traffic control; parking management; automated driverless transport; anticollision systems; smart card; drive-by-wire; vision enhancement; autonomous intelligent cruise control; fleet management; integration of information technologies; rail traffic management for long-distance passenger and freight; lane keeping; and driver monitoring.

346 http://www.iea.org

347 Deffeyes, Kenneth. 2001. *Hubbert's Peak: The Impending World Oil Shortage*. New Jersey: Princeton University Press.

348 England is building 18 offshore wind farms housing 6,000 turbines and Denmark expects to derive half of its energy from wind. European wind power overall grew from 500 megawatts in 1990 to 23,000 in 2002, a 50-fold increase. (*Fortune.* 2003. A Mighty Wind. 22 Dec.) The US is investing $3 billion in wind power because North Dakota, Kansas, Texas, and other states alone could provide all of America's energy needs. Experts estimate that wind power could supply 12% of the world's energy needs by 2020.

349 Photovoltaic cells (PVC) presently cost $4/watt, compared with $.40/watt for oil and gas. But costs are expected to reach $1/watt by 2007, and companies like Nanosys are using nanotech to build plastic PVCs costing $0.20/watt that are 70% efficient compared with the present 20%. (*The Economist.* 2002. The End of the Oil Age. 20 Jun.) Japan has 80,000 homes with solar panels, and 10% of new homes have solar panels. German solar power has grown 300% in 2 years, with 120,000 homes having solar panels. British Petroleum is building a $100-million solar plant. The solar energy reaching Earth is 10,000 times our global energy consumption. It is thought that a patch of thermal solar plants in the Sahara 500 kilometers across could meet the world's entire energy needs. (*New Scientist*. 2004. Power of the Midday Sun. 10 May.)

350 About 70% of Americans now favor nuclear energy. Nuclear produces no pollution, has a sound safety record, and costs 1.9 cents/kwh compared with 3.4 cents for oil and gas. An International Atomic Energy Agency study found that oil pollutants kill 32 times as many people as nuclear. New designs like the "pebble bed" reactor are immune to meltdowns and storing waste in glass (vitrification) can be safe for 200,000 years. The head of the US Nuclear Regulatory Commission was surprised to note interest in building new plants: "The possibility was unthinkable a year ago." The PRC alone is planning to build 30 nuclear reactors.

351 *New Scientist.* 2003. The Clean Green Energy Dream. 16 Aug.

352 Analysts expect distributed power to produce 20% of all electric energy by 2010. John Benner, National Renewable Energy Lab, thinks local power sources will supply 25% of new capacity by 2020. 2000. *Purdue Extrapolations*. Winter.

353 *Technology Review*. 2004. Biotech Crops About to Bloom. 16 Jul.

354 *Sydney Morning Herald*. 2004. City with a Future. 15 May.

355 *New Scientist*. 2004. Smog-Busting Paint. Feb 4.

356 United Nations Association of Greater Boston. 2003. Water Scarcity: Averting a Global Crisis. Conference on Public Private Sector Collaboration in Addressing the UN Millennium Water and Sanitation Goals, Massachusetts, 22 May.

357 *Fortune.* 2000. Water, Water Everywhere. 15 May.

358 Ovation Products, for instance, claims it can distill water contaminated with anything into pure drinking water for about 1 cent/gallon. (*Technology Review*. 2003. Would You Drink Purified Sewage? 22 Dec.)

359 For instance, the French firms, Vivendi and Suez, are the largest water treatment companies in the world and growing rapidly. In 1999, Suez had annual sales of $32 billion. (*Fortune.* 2000, Water, Water Everywhere.15 May.) California is building 13 plants that could supply 10–20% of the State's water. Florida is building a $110-million plant, the largest in the Western hemisphere, and Texas is planning 9 plants. Israel has 5 large projects. CDT Systems has developed a "capacitative deionization" technique that produces clean water at half the cost of the conventional reverse osmosis technique. (*Technology Review.* 2003. Hold the Salt. 24 Dec.)

360 *Christian Science Monitor*. 2003. How to Feed the World. 20 Feb.

361 *Los Angeles Times*. 2002. Organic Farms Viable Despite Lower Yields. 21 May.

362 *Croplife*. 2002. Digitize It. Dec.

363 One study found a yield monitor useful only when combined with global positioning systems. Another found variable rate fertilizers to be unprofitable on wheat and barley, sometimes profitable on corn, and profitable on sugar beets. (*Journal of the ASFMRA*. 2002.)

364 *Croplife*. 2001. Seed Money. Dec.

365 *Apply*. 2004. From the Top. 1 Feb.

366 Mining data is from the Industrial Technologies Program website, http://www.oit.doe.gov. Information on the PRC is from: Kurtenbach, Elaine. 2004. China Paying Price for Industrial Boom. *Associated Press Online.* 1 Jan.

367 Kawatra, S Komar, and K A Natarajan. 2001. *Mineral Biotechnology. Society for Mining, Mettalurgy, and Exploration. Mining Industry Roadmap for Crosscutting Technologies.* http://www.oit.doe.gov

368 Ibid.

369 Mellon, Margaret, and Jane Rissler. 2003. *Environmental Effects of Genetically Modified Food Crops. Union of Concerned Scientists.* Paper presented by Margaret Mellon at a conference, Genetically Modified Foods—the American Experience, sponsored by the Royal Veterinary and Agricultural University, Copenhagen, Denmark, June 12–13, 2003.

370 *New Scientist*. 2002. 20-year Study Backs Organic Farming. 30 May.

371 NASA has set up an Office of Exploration Systems to develop technologies for the proposed moon mission. By 2008, the crew exploration vehicle (CEV), which ferries astronauts to and from the moon, will be tested for a manned mission in 2014. The European Union has its own plan, Aurora, to construct a permanent moon base from which to launch Mars missions. They envisage collaborating with the US New rocket motors, hybrid fuels, and myriad technologies can be used to create even more powerful rockets. TransHab, a multi-storey inflatable habitat, can provide semi-permanent accommodation for up to six astronauts. (*New Scientist.* 2004, 31 Jan. Ibid)

372 *MicroScope***.** 2004. Biometrics: Next Killer App. 24 May.

373 *Technology Review***.** 2003. Boosting Biometrics. Jun

374 The UK is setting up a National Identity Register based on biometrics for its 600 million citizens. The Enhanced Border Security Act will upgrade all US passports and visas to biometrics at a cost of $3.2 billion over three years. The Department of Defense worldwide information infrastructure based on biometrics will be in place by 2010. The European Union will start issuing biometric passports in 2005 and uses fingerprints to identify people at borders. Suruga Bank launched Japan's first biometric deposit account in July 2004. Japan's NTT DoCoMo launched the world's first biometric-enabled phone in July 2003. (*Wireless Week.* 2004. Eyeing Biometrics 15 Jan.) Forty-two airports are using electronic fingerprint-scanning technology, often in combination with RFID tags. New York's John F. Kennedy Airport is implementing a $1.2 million iris recognition project. (*Airport Security Report.* 2004. Airports to Deploy Biometrics. 19 May.)

375 Lehman Brothers thinks the market for biometrics will grow 30–35% annually, and another study estimates growth at 37%. (*Security Systems News.* 2004. IBG Report Predicts Double Digit Growth for Biometrics. Feb.) Sales of biometrics were $600 million in 2002, $1 billion in 2004, and are expected to exceed $4 billion by 2007. It is thought that fingerprints will replace credit cards by 2007. (*Wireless Week*. 2004. Eyeing Biometrics.15 Jan.)

376 IDC expects Internet traffic to double annually the next 5 years due to broadband. IDC. 2003, 27 Feb. Broadband Will Drive Internet Growth. www.IDC.com.

377 Verizon and Bell South are investing $20 billion in fiber optic cables running at 30 Mbps to 36 million homes, a 20-fold increase in speed. NTT, Fujitsu, and the Japanese government are planning to install cables operating at 10 Gbps by 2010, 100 times faster than their current 100 Mbps connections and a 10,000 times faster than in the US. (*TechCrazy.* 2004. Internet Will Hit 10 Gbit by 2010. 29 Aug.) New versions of WiFi operate at 70 Mbps, an order of magnitude faster than today's broadband, and Internet II runs at 7 Gbps, a thousand times faster. (*New York Times*. 2003. Schools Keep Vigil for Internet. 14 Aug.)

378 At the end of 2003, Jupiter says 33% of US households used broadband, while a PEW study put it at 31%. By 2005, Yankee expects use to reach 40%, and Jupiter says 38%. Forrester Research expects 38% of households to use broadband in 2005, 47% in 2006, 55% in 2007, and 62% in 2008.

379 IBM and Microsoft have speech recognition program that are expected to reduce the error rate from 95% to 99% by 2010, thereby matching humans. An IBM scientist said "We have made very good progress … and crossed the threshold where users will accept it." (*News Com*. 2003. Talking Computers Nearing Reality. 9 Jul.) Speech recognition call centers are replacing the maddening touch-tone call centers. Amtrak's "Julie" provides strain schedules, makes reservations, and accepts payment; customer satisfaction is up and Amtrak recovered its investment in one year. AT&T Labs is developing a voice controlled "Intelligent Secretary" to handle calls, organize files, transmit documents, and schedule meetings. Nokia, Sony, and other companies are creating intelligent agents operating on 3G mobile phones that make purchases, among other tasks. (*New Scientist*. 2003. Smart Cellphones Would Spend Your Money. 15 Jun.) The National Science Foundation has sponsored research to move speech recognition from software onto chip designs, making it 1,000 times more effective. www.Kurzweilai.net

380 A wide variety of AI is being used now by the military and for risk management, financial analysis, process and quality control, biometrics, spot shifts in credit card usage patterns, biometrics, interpret facial expressions, filter spam, manage PCs, create video games, diagnose medical problems, trade securities, etc. The entrance to Cambridge University has replaced its attendant

with a robotic head that gives visitors information. DARPA is developing a hyper-smart computer that can maintain itself, make adaptive changes, and respond to different situations. It has also invested millions in Carnegie Mellon's "Perceptive Assistant that Learns" (PAL) and SRI's "Cognitive Agent that Leans and Observes" (CALO). (*Post-Gazette.* 2003. CMU Team to Develop Software "Secretary." 17 Jul.*)* The US Department of Energy is developing systems that infer intent, remember experiences, and make decisions. The scientist in charge thinks "cognitive systems will be embedded in most computers within 10 years." IBM's "autonomic computing" allows computer systems to solve problems and reconfigure themselves to reach a goal, just as organisms use an autonomic nervous system to regulate heartbeat and body temperature. *Wired.* 2003. Machine Thinks, Therefore I Am. 27 Aug.

381 The old 32-bit chips made today's graphical user interface possible (windows), and the 64-bit chips are designed for speech recognition, video, and other advanced capabilities.

382 Roughly half of US firms were installing voice recognition call systems in 2004, and all are expected to do so in 1–2 years, with a potential market of $3.5 billion by 2007. The market for speech recognition should reach $5 billion by 2008. (*New Scientist.* 2003. No One Understands Me As Well As My PC. 1 Nov.) One expert thinks the market will reach $20 billion by 2013. Total AI sales is expected to grow from $1 billion in 1993, to $12 billion in 2002, to $21 billion in 2007. A futurist thinks AI will allow voice commands to be used for 3D Internet, television, mobile phones, medical care, and other services by 2010–2020. Scientists generally estimate that computer power will match the human brain by 2020. (Kurzweil, Ray. 2002. *The Age of Spiritual Machines*. New York: Viking.) The CEO of Native Minds, a virtual robot maker, thinks "The Internet will be filled with robots by 2010."

383 *Boston Globe.* 2002. MIT Researchers Working to Make Computers Intuitive. 12 Aug.

384 Fifty nations joined together to create the Global Earth Observation System of Systems that will continually monitor land, sea, and air around the world. The network integrates 10,000 weather stations, 1,000 buoys, 100,000 daily observations by 7,000 ships and 3,000 aircraft, and 50 weather satellites. (*Washington Post.* 2004. Nations Collaborate to Take Planet's "Pulse." 26 Jul.) Radio Frequency ID tags (RFID) are being used to identify and track everything from groceries to people. Wal-Mart now requires suppliers to attach RFID tags to their products. AeroAstro Corporation produces "nanosatellites"—small communication satellites designed to monitor the movement of cargo, the location and health of people, maintenance status of machinery, and almost any other activity. "Smart dust"—sensors the size of rice seeds—are being dispersed through the winds to monitor traffic, weather, the environment, and military intelligence. A computer scientist is developing tiny "motes" that only use power when relaying data to each other so they can be powered by small batteries. *Technology Review*. 2003. Wireless Sensor Networks. Feb. Many firms are working together to develop a common standard for communications among home appliances via the Internet. The 3G mobile phone system is being converted into a "machine-to-machine" (M2M) system that connects cars, security systems, and other devices into an intelligent network. Analysts expect 26-100 million micro-devices of this type to be in use by 2006. Wireless home networks are introducing a "digital home" in which electronic components can be connected together easily. GE, Whirlpool, and Sunbeam are introducing Internet-equipped appliances. (*BusinessWeek.* 2003. Digital Homes. 21 Jul.)

385 *Technology Review.* 2003. Quantum Cryptography. Feb.

386 *Electronic Engineering Times.* 2002. Error May Stall Quantum Computing. 9 Dec.

387 *InfoWorld.* 2003. Japan Reports Quantum Computing Breakthrough. 29 Oct.

388 *New Scientist.* 2004. First Quantum Cryptography Network Unveiled. 16 Jun.

389 NEC Corp. succeeded in controlling superposition and entangled two solid-state qubits, demonstrating two keys to quantum computing. The US NIST transmitted a single photon as the key to an encrypted message at 100 times the previously recorded speed. IBM and Stanford University are pioneering the new field of "spintronics," which manipulates the spin of electrons to store information. Researchers have successfully entangled 5 photons. (*TRNMag.com*. 2004. Five Photons Linked. 30 Aug.)

390 Ibid.

391 SimDesk provides cheap access to basic programs (word processing, e-mail, etc.), processing power, and storage for a few dollars per person per year. The service is used by 200,000 people in Houston, 400,000 students in Chicago, 6 million people in Indiana, and the firm is working with 31 other states plus some nations. (*BusinessWeek.* 2004. A Sweet Deal in Suite Software. 5 Jul.*)* IBM is investing $10 billion to make utility computing the heart of its corporate strategy, "E-Business on Demand." It is also introducing "Workplace" as a server-based alternative to Microsoft Office. "This is exactly what customers want," said the CEO, Samuel Palmisano. "It's going to drive phenomenal productivity." Hewlett-Packard and Sun are developing an "intraorganizational" approach. HP's "Utility Data Center" and Sun's "N1" system both provide more effective computing networks to serve units within a corporation. (*BusinessWeek*. 2003. Utility Computing. 25 Aug.)

392 For instance, H-P, GM, and the DoD use VR systems to let design teams walk through autos, ships, and aircraft before building prototypes, saving millions of dollars in design work and time. (*The Futurist*. 2002. Virtual Reality is Getting Real. May-Jun.)

393 Broadband, wireless, speech recognition, AI, and more powerful computers should improve VR considerably (see Intelligent Interface). Japanese researchers have developed hologram projectors on a circuit board to be used for 3D TV, movies, and video. Commercial products are expected in 3–5 years. Digital Research Labs has created 3D movies that surround the viewer. (*New York Times*. 2004. For the Viewer, No Escape Hatch in a Digital 3-D Film. 6 May. Olympus and Sony have introduced comfortable goggles that project vivid video and sound, enabling full body interaction with a virtual environment without the hassle of bulky, dizzying 3D glasses.

394 "There" is a multimedia website featuring 3D computer-generated environments populated with avatars that interact with users and other avatars. The UCLA Virtual Reality Lab recreates ancient Rome with 3D images of temples and monuments that users can walk around in. Planetariums have begun providing people the experience the sensations of flying through space. VR tools are being used to create 3D x-rays to help surgeons plan procedures or assist in surgery miles away. Media companies are introducing "virtualized reality" that should soon allow the viewer to ride a football from the quarterback to the receiver. Hidden relationships in complex data sets can be grasped quickly. For instance, VR enables more accurate decisions in financial markets. The Waldorf Astoria Hotel in New York City has been using a 4X7 foot video conferencing system for years, and is so convenient that it is always booked. Virtual "walk-through displays" are being used in museums. Internet 2 offers "tele-immersion," which allows people to walk around a virtual object and to hold virtual meetings with 3-dimensional images.

395 http://www.kurzweil.ai. 2003. Kurzweil Teleports in 3-D to World Economic Forum. 24 Sep.

396 *Washington Post*. 2002. Wireless Computing. 23 May.

397 The name commonly given to the IEEE 802.16 standard.

398 A third-generation standard offering broadband mobile data with a peak rate of 2.4 Mbps.

399 EvDO technology may surpass WiFi because it can operate at comparable speeds over existing cell networks to provide seamless coverage. Motorola Labs has operated multiplexing wireless technologies at 300 Mbps, speeds, which were previously thought unattainable.

400 Forrester Research. http://www.forrester.com.

401 *Fortune.* 2002. Death to Bureaucrats. 26 Jun.

402 *DM News.* 2003. Virtual Shopping Habits. 27 Aug.

403 *BusinessWeek.* 2003. E-Shoppers Are Now E-Spenders. 8 Dec.

404 *New York Times.* 2000. Where Video Will Come From. 13 Aug.

405 *BusinessWeek.* 2002. The Battle of Online Content Models. 13 May.

406 *On the Horizon.* 2003. The Online Education Market: Much Is at Stake for Institutions of Higher Education 11 (3).

407 *New York Times.* 2003. Professor View with Web for Class's Attention. 2 Jan.

408 *Chronicle of Higher Education.* 2003. Survey Finds College Administrators Optimistic About the Future of Online Education. 4 Sep.

409 http://www.ban.org

410 *New Scientist.* 2004. We Can Rebuild Them. 28 Feb; *Washington Post*. 2004. Firm Strives to Give Amputees Natural Gait. 12 Apr; http://www.News.Scottsman.com.

411 http://www.longbets.com

412 By sending brain signals through the array, Warwick was able to control a wheelchair and an intelligent artificial hand. His signals were also sent to a less complicated chip implanted in his wife's arm. Warwick believes that "the step to Cyborgs—part human part computer—offers humans a natural, technological upgrade" with extraordinary capabilities. www.rdg.ac.uk/KevinWarwick.

413 *Newsweek.* 2001. Full Stem Ahead. 12 Feb.

414 *New Scientist.* 2001. Stem Cell 2001 "Immortality" Gene Found. 5 Mar.

415 Hall, Stephen. 2003. *Merchants of Immortality*: Chasing the Dream of Human Life Extension. New York: Houghton-Mifflin

416 For instance, Dr. James Vaupel, Director of the Lab on Longevity at the Max Planck Institute, finds that life spans will increase 2 to 3 years per decade, and he forecasts life spans approaching 130 years by 2050. Prof. Aubrey de Grey at University of Cambridge claims average life spans will reach 130 years by 2030. The Center for Strategic and International Studies thinks a female born today will have a 40% chance of living to 150 years.

417 *Washington Post.* 2000. The Promise of Precision Prescriptions. 24 Jun.

418 Perlegen Sciences is developing more convenient tests based on identifying the differences in genetic makeup between people who are prone to certain illnesses, rather than analyzing the entire genome. (*Technology Review*. 2004. Personal Genomics. Feb.) Dr. Craig Venter, the scientist who almost single-handedly deciphered the human genome, has launched the world's largest genome sequencing center to make genetic tests commonly available. "Our goal is to do a whole genome analysis in minutes or hours," he said. Research is identifying which patients will respond to different cancer drugs. A scientist called it "The most striking advance in decades." (*BusinessWeek.* 2004. Taking Better Aim at Cancer. 10 May.*)* Some experts think it will be common for patients to be genetically tested before treatment at about 2010. (*Washington Post.* 2000. The Promise of Precision Prescriptions. 24 Jun.)

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