CHAPTER 4

The Environmental Effects on Consumption

CHAPTER OBJECTIVES

A. Identify Environmental Action Designed to Reduce Climate Change

B. Understand Efforts to Influence the Supply and Demand for Energy

C. Environmental Action Designed to Reduce Human Influences on the Atmosphere

D. Environmental Action Designed to Reduce Human Influences on Water

E. Environmental Action Designed to Reduce Human Influences on Land

F. Environmental Action Designed to Reduce Human Influences on Biodiversity

G. The Role of Energy Conservation Efforts to Limit Climate Change and Pollution

A. Identify Environmental Action Designed to Reduce Climate Change

TUNGU-KABIRI COMMUNITY MICRO-HYDROPOWER

The Meru South District area in central Kenya is an area teeming with beautiful landscapes and rich natural resources. Like much of Africa, however, this region is not adequately served with electrical power. One of the most viable and sustainable ways to bring electrical power to the region is in the form of hydroelectrical power. Hydroelectrical power is a time-proven technology that relies on a nonpolluting, renewable, and indigenous resources. The technology can easily be integrated into irrigation and water supply projects. China, for instance, has more than 85,000 small electricity-producing hydro-power plants.[1]

The potential for hydropower is massive and in many ways an untapped resource. Hydropower accounts for 20% of the world's supply of electricity, and it is an important source of renewable energy in the United States, Canada, and Norway.[2] Nevertheless, 70% of the economically feasible hydro potential in developing countries—and 93% of the potential in Africa—remains unexploited.[3]

Hydropower can be developed on multiple scales ranging from *large-hydro* plants of more than 100 megawatts to *pico-hydro* plants of less than 5 kilowatts. In the Meru South District of Kenya, a micro-hydro plant capable of producing 18 kilowatts was developed to serve 400 households in the Tungu-Kabiri community. Members of the community formed a commercial enterprise by purchasing shares having a maximum value of approximately US$50. The group members also dedicated one day per week to the construction of a run-of-the-river penstock micro-hydropower system (see Figure 4–1). The community also acquired an acre of land from the government, where it built an enterprise center that receives power through the project. The Small Grants Programme of the United Nations also contributed US$63,700 to support project completion.

The construction of this micro-hydropower facility has paid substantial dividends across the triple bottom line of sustainability.[4] Revenue has increased due to the running of the micro-hydro enterprise. Consequently, there is a demand for services such as welding operations, barber shops, beauty salons, and battery changing stations. The environment simultaneously benefits as grain milling is transferred from diesel engines to hydropower and electricity replaces kerosene

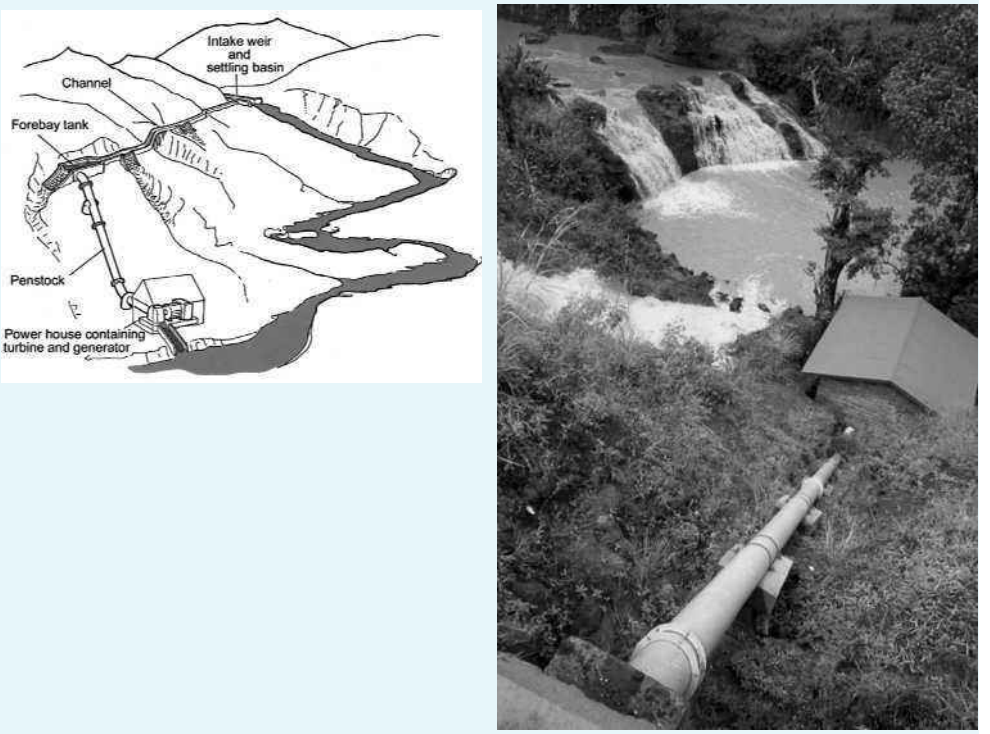

FIG. 4-1 Micro-Hydropower Schematic and Photo of the Tungu-Kabiri Facility in Kenya

Source: © *Practical Action/Zul*

used for lighting. The notoriety of this successful venture has stimulated interest in building at least two more power plants in the region.

The Kenya example illustrates how people are taking action to confront sustainability issues. In the last chapter, we focused on the influences that consumption has on the environment. In this chapter, we identify activity occurring outside the firm designed to influence consumption. The environment of the firm can be conceptualized as consisting of multiple levels.[5] At one level, the environment concerns entities close to an organization that influence the ability to serve customers. These entities include the company, customers, suppliers, competition, marketing intermediaries, and other groups (i.e., publics) that influence the ability to meet objectives. Because the relationships between these entities and the firm directly influence day-to-day operations, we dedicate the remaining chapters of this book to these relationships. In Part III, we outline the marketing efforts of organizations operating in these macro-environments. In Part IV, we outline the macro-environment of the primary users of energy (industry, households, services, and transportation).

The environment also includes the larger forces that frame the activity of the firm and other participants in a market. These forces include the natural, technological, political, economic, and cultural constraints on operations within a market. Chapter 3 calls attention to influences of technology and culture on the natural environment. Our discussion here considers political and economic forces that shape operations in an industry. We begin by examining efforts to regulate climate change and then engage in a discussion of efforts to influence the supply and demand for energy. In the

subsequent sections, we identify macroenvironmental efforts to reduce human influence on the atmosphere, water, land, and biodiversity.

Numerous efforts have been launched to address the influences of consumption and other human activity on the environment, and these activities have taken place at the international, national, regional, and local levels. Although international agencies and national governments enact policies and legislation, local activity determines whether these initiatives are successful.

Consider now macroenvironmental efforts to limit climate change.

The most prominent international effort to reduce climate change is the **Kyoto Protocol**.[6] The Kyoto Protocol was adopted by the United Nations in Kyoto, Japan, on December 11, 1997, and implementation began on February 16, 2005.[7] The Kyoto Protocol limits emissions of greenhouse gases (GHG) (carbon dioxide, methane, nitrous oxide, and fluorinated gases) from the 35 industrialized countries listed in Table 4–1.

The goal of the Kyoto Protocol is to limit the anthropogenic emission of greenhouse gases. The protocol has been developed as an attempt to reduce overall emissions of greenhouse gases by at least 5% below 1990 levels during the commitment period from 2008 to 2012. In order to achieve this objective, countries were designated some percentage of the base year as an objective for the emissions of GHGs during the 2008 to 2012 horizon. For example, targeted emissions in the United States reflected 93% of the emissions in 1990. Thus, compliance with the Kyoto Protocol requires reductions

TABLE 4-1[9] EMISSION LIMITATIONS ESTABLISHED BY THE KYOTO PROTOCOL

PARTY	EMISSION LIMITATION, %	PARTY	EMISSION LIMITATION, %
Australia	108	Liechtenstein	92
Austria	92	Lithuania*	92
Belgium	92	Luxembourg	92
Bulgaria*	92	Monaco	92
Canada	94	Netherlands	92
Croatia*	95	New Zealand	100
Czech Republic*	92	Norway	101
Denmark	92	Poland*	94
Estonia*	92	Portugal	92
European Community	92	Romania*	92
Finland	92	Russian Federation*	100
France	92	Slovakia*	92
Germany	92	Slovenia*	92
Greece	92	Spain	92
Hungary*	94	Sweden	92
Iceland	110	Switzerland	92
Ireland	92	Ukraine*	100
Italy	92	United Kingdom	92
Japan	94	United States of America	93
Latvia*	92		

*Countries that are undergoing the process of transition to a market economy.
Source: *From Kyoto Protocol to the United Nations Framework Convention on Climate Change, (Kyoto, Japan: © United Nations, 1998), p. 20. Reprinted with the permission of the United Nations.*

in emissions associated with fuel combustion, industrial processes (e.g., mineral products, chemicals, metal production), agriculture, and waste management.

Importantly, the Kyoto Protocol outlines *national* efforts to reduce or limit greenhouse gases. In addition, the protocol introduced three *market* mechanisms that enable countries to engage in international commerce to meet emission targets.[8] These mechanisms stimulate sustainable development via the transfer of technology and investment, and they encourage the private sector and developing countries to contribute to emissions reductions. Furthermore, they help countries to meet their commitments by cost-effectively removing GHGs from the atmosphere in other countries.

A central advantage of the Kyoto Protocol lies in the designation of emissions levels for participating countries. Designation of emission levels created a market for the sale and purchase of greenhouse gas emissions. Three Kyoto mechanisms that facilitate the exchange of emission credits are as follows:

Emissions trading *Emissions trading* refers to the exchange of carbon trading units. The participating countries listed in Table 4–1 allocate carbon trading units to industries such as manufacturing and utilities.[10] Companies in these industries within these countries are required to reduce emissions to the target levels outlined in Table 4–1. If the companies attain emission levels below targeted rates, they can sell the emission credits on an exchange. For example, the European Carbon Exchange (ECX) attracts more than 89% of the global exchange volume with more than 100 participating businesses.[11] If companies surpass their emission levels, they must go to a market and buy **carbon offsets**. These offsets often are investments in developing countries such as China and India. Investments in carbon offsets reduce the emissions in the emerging markets and thereby contribute to lower global emissions.[12]

The European Union's European Trading Scheme (ETS) currently accounts for about two thirds of global **carbon** trading. Because the United States did not ratify the Kyoto Protocol, its carbon exchange market is voluntary. The U.S. market is owned by the Climate Exchange, the parent company of ECX, and is named the Chicago Climate Exchange (CCX).[13] More than 300 parties have become members of this organization since its founding in 2003. A similar market forming in the United States is the Regional Greenhouse Gas Initiative. The initiative is a multistate government program aimed at reducing power plant emissions in the Northeast. This program commenced in 2009.[14]

Clean development mechanism (CDM) The clean development mechanism enables emission reduction or removal projects in developing countries to earn **certified emission reduction** (CER) credits.[15] Each CER is equivalent to one ton of carbon dioxide. CERs can be traded, sold, or used to meet emission targets outlined by the Kyoto Protocol.

Industrialized countries that finance investment projects for greenhouse gas emission abatements in developing countries generate credits used to meet their own commitments. The industrialized countries reduce carbon emissions at a lower marginal cost than domestically. Developing economies gain access to technology more rapidly while simultaneously reducing emissions. They have the opportunity to accelerate technological transfers and to benefit from positive spinoffs in terms of development.[16] Since the beginning of operations in 2006, the clean development mechanism has registered more than 1,000 projects amounting to more than 2.7 billion tons of carbon dioxide.

Joint implementation (JI) Joint implementation is similar to the clean development mechanism given that it relies on collaboration between countries to lower GHG emissions. In contrast to CDMs that involve an industrialized country and a

developing country, however, joint implementation projects involve only industrialized countries.[17] Participants to JI arrangements earn **emission reduction units** (ERUs) each equivalent to one ton of carbon dioxide that can be counted toward Kyoto Protocol targets. For example, in 2007 New Zealand established a joint implementation program with the Netherlands to provide a wind farm at Te Apiti on New Zealand's northern island.[18] The project is expected to earn 530,000 ERUs.

JI programs offer benefits to the host country (e.g., New Zealand) and the nonhost partner (e.g., the Netherlands). The host country receives foreign investment and technology transfer, while the nonhost country obtains a flexible and efficient means for meeting its Kyoto requirements.

Although 182 Parties of the Convention have ratified the Protocol as of this writing (see Table 4–2), the United States and Australia have refused to participate. While the United States federal government has not endorsed the Kyoto Protocol, 14 U.S. states have adopted the GHG emission targets established by the United Nations. Of the 650 cities worldwide that have adopted Kyoto GHG emission targets, 212 are in the United States. Moreover, the U.S. Environmental Protection Agency (EPA) has established a climate leader partnership that currently includes more than 200 U.S. companies. These corporate partners commit to reducing their impact on the global environment by taking stock of current gas emissions, setting aggressive reduction goals, and annually reporting their progress to the EPA.

B. Understand Efforts to Influence the Supply and Demand for Energy

Many countries throughout the world have established regulations designed to enhance the sustainability and efficiency of energy consumption. The desire to conserve energy is not a new phenomenon, but it is gaining increasing interest due to climate change and rising oil prices. One way to examine energy is on the basis of its supply and demand. Renewable energy sources provide contributions to the supply of energy. To the extent that these sources are employed as substitutes for fossil fuels, the environment does not encounter the negative consequences of oil or other fossil fuel consumption.

Renewable energy sources will increase throughout the world, but the demand for energy will also continue to rise.[19] It is therefore important to consider the mechanisms that influence the demand for energy. While conservation efforts are being undertaken in many industries, we focus attention here on transportation, buildings and construction, and appliance industries due to the amount of regulation and opportunity for substantial reductions in energy usage.

Consider first the role of renewable energy.

Renewable Energy

Energy consumption across the globe is growing at a rapid rate, and current predictions suggest that energy consumption will grow by 60% in the next 25 years.[20] Figure 4–2 indicates the share of energy and electricity use throughout the world. Note that of the 13% associated with renewable forms of energy, 8% of this total is associated with traditional biomass. Other forms of renewable energy account for 5% of usage throughout the world. Renewable energy technologies have made tremendous advances over the last 20 years and offer significant advantages over conventional fuels for meeting energy needs. Research indicates that adding renewable energy to a fossil fuel-dominated energy portfolio reduces generating costs and enhances energy security.[21]

TABLE 4-2[22] PARTIES TO THE KYOTO PROTOCOL

Albania	Ecuador	Liechtenstein	Romania
Algeria	Egypt	Lithuania	Russian Federation
Angola	El Salvador	Luxembourg	Rwanda
Antigua and Barbuda	Equatorial Guinea	Macedonia	Saint Lucia
Argentina	Eritrea	Madagascar	Saint Vincent and the Grenadines
Armenia	Estonia	Malawi	Samoa
Australia	Ethiopia	Malaysia	Saudi Arabia
Austria	European Community	Maldives	Senegal
Azerbaijan	Fiji	Mali	Serbia
Bahamas	Finland	Malta	Seychelles
Bahrain	France	Marshall Islands	Sierra Leone
Bangladesh	Gabon	Mauritania	Singapore
Barbados	Gambia	Mauritius	Slovakia
Belarus	Georgia	Mexico	Slovenia
Belgium	Germany	Micronesia	Solomon Islands
Belize	Ghana	Moldova	South Africa
Benin	Greece	Monaco	Spain
Bhutan	Grenada	Mongolia	Sri Lanka
Bolivia	Guatemala	Montenegro	Sudan
Bosnia and Herzegovina	Guinea	Morocco	Suriname
Botswana	Guinea-Bissau	Mozambique	Swaziland
Brazil	Guyana	Myanmar	Sweden
Bulgaria	Haiti	Namibia	Switzerland
Burkina Faso	Honduras	Nauru	Syrian Arab Republic
Burundi	Hungary	Nepal	Thailand
Cambodia	Iceland	Netherlands	Togo
Cameroon	India	New Zealand	Tonga
Canada	Indonesia	Nicaragua	Trinidad and Tobago
Cape Verde	Iran (Islamic Republic of)	Niger	Tunisia
Chile	Ireland	Nigeria	Turkmenistan
China	Israel	Niue	Tuvalu
Colombia	Italy	North Korea	Uganda
Congo	Jamaica	Norway	Ukraine
Cook Islands	Japan	Oman	United Arab Emirates
Costa Rica	Jordan	Pakistan	United Kingdom
Côte d'Ivoire	Kenya	Palau	United Republic of Tanzania
Croatia	Kiribati	Panama	Uruguay
Cuba	Kuwait	Papua New Guinea	Uzbekistan
Cyprus	Kyrgyzstan	Paraguay	Vanuatu
Czech Republic	Laos	Peru	Venezuela
Congo	Latvia	Philippines	Viet Nam
Denmark	Lebanon	Poland	Yemen
Djibouti	Lesotho	Portugal	Zambia
Dominica	Liberia	Qatar	
Dominican Republic	Libyan Arab Jamahiriya	Republic of Korea	

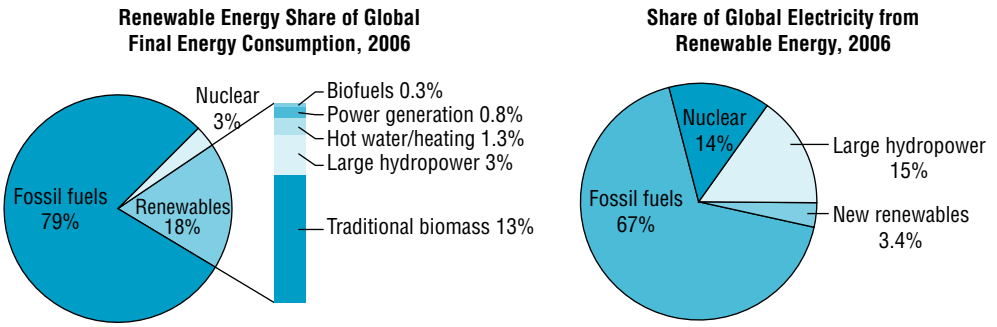

FIG. 4-2 Renewable Energy Share for Final Energy Consumption and Electricity

Source: *Renewable Energy Policy Network for the 21st Century*

The Renewable Energy Policy Network[23] emphasizes the following benefits to renewable energy:

1. Use locally available, renewable resources such as the sun, wind, biomass, geothermal, and hydropower.
2. Reduce reliance on fossil fuels and their associated international trade consequences.
3. Heighten energy security by developing a diverse energy portfolio.
4. Increase price stability during volatile periods for fossil fuel prices.
5. Reduce risk of future energy costs.
6. Increase income, revenue, and job opportunities. Renewable energy supports 2.4 million jobs globally.[24]
7. Conserve the natural resource base in a country.
8. Provide health benefits, notably to women and children, via improved cooking facilities.
9. Contribute to economic and social development via provision of modern energy services, including lighting, heating, cooking, cooling, water pumping, transportation, and communications.
10. Remain environmentally friendly because they lack nitrogen and sulfur oxides that are harmful to humans, animals, and plants, and carbon dioxide and that contribute to climate change.

Due to the simultaneous potential to use local resources and limit climate change, 66 countries have set national targets for renewable energy supply.[25] The European Union, for instance, seeks to have 21% of its electricity and 12% of total energy served through renewable sources by 2010. In the United States, 29 states have developed mandatory renewable energy percentages for utilities, and another four states have voluntary programs[26] (see Figure 4–3 and 4–4). Most national or state targets reflect desires for 5 to 30% of electricity production during the 2010 to 2012 horizon. Brazil, China, the Dominican Republic, Egypt, India, Malaysia, Mali, the Philippines, South Africa, and Thailand are emerging economies that have established renewable energy targets. Developing countries have more than 40% of existing renewable power capacity, more than 70% of existing solar hot water capacity, and 45% of biofuel production. China has targeted 10% percent of total power capacity by 2010, whereas India anticipates that 10% of its electric power capacity will be filled via renewable energy sources by 2012.

In 2007, worldwide renewable electricity generation capacity reached an estimated 240 gigawatts (GW), an increase of 50% over 2004. Table 4–3 outlines

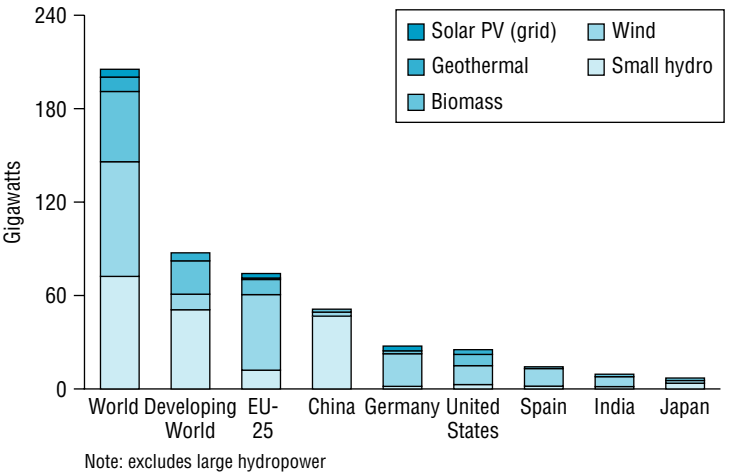

FIG. 4-3 Renewable Power Capacities, Developing World, EU, and Top Six Countries, 2006

Source: *REN21.2008. Renewables 2007 Global Status Report (Paris: REN21 Secretariat and Washington, DC: Worldwatch Institute). http://www.ren21.net/pdf/RE2007_Global_Status_Report.pdf (accessed August 22, 2008).*

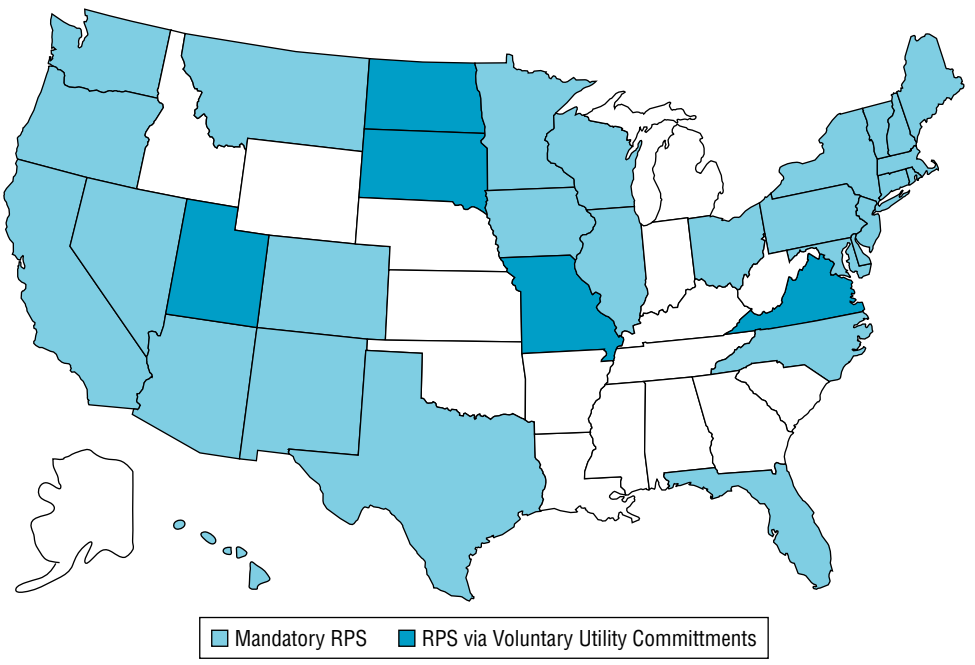

FIG. 4-4 U.S. Renewable Portfolio Standards (RPS)

Source: *Pew Center on Global Climate Change. http://www.pewclimate.org/what_s_being_done/in_the_states/rps.cfm (accessed August 22, 2008).*

several indicators of renewable energy. Renewable energy sources such as hydropower, wind, solar, geothermal, biomass, tidal, and wave technology enable utility companies, individuals, and organizations to meet their energy needs. Note that hydroelectric power, a renewable source that has been in use for decades, generates

TABLE 4-3[25] INDICATORS OF RENEWABLE ENERGY

SELECTED INDICATORS	2005	2006	2007	(ESTIMATED UNITS)
Investment in new renewable capacity (annual)	40	55	71	Billion US dollars
Renewable power capacity (existing, *excluding* large hydro)	182	207	240	Gigawatts
Renewable power capacity (existing, *including* large hydro)	930	970	1,010	Gigawatts
Wind power capacity (existing)	59	74	95	Gigawatts
Grid-connected solar PV capacity (existing)	3.5	5.1	7.8	Gigawatts
Solar PV production (annual)	1.8	2.5	3.8	Gigawatts
Solar hot water capacity (existing)	88	105	128	Gigawatts
Ethanol production (annual)	33	39	46	Billion liters
Biodiesel production (annual)	3.9	6	8	Billion liters

Source: *Renewable Energy Policy Network for the 21st Century, Renewables 2007 Global Status Report, (Paris, France: REN21 Secretariat and Washington, DC: Worldwatch Institute, 2008), p. 8. Copyright © 2008 Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.*

almost four times as much energy as all other renewable sources. Investments in 2007 in hydropower exceeded $15 billion.

Of the $71 billion invested in other new renewable energy sources during 2007, 47% was for wind power and 30% was for solar photovoltaic (PV). Figure 4–5 illustrates the growth in windpower over the last decade. The 28% growth in global wind generating capacity in 2007 was the largest increase in renewable power. In the United States, more than 25,000 turbines produce enough to power 4.5 million homes (17 gigawatts). Total U.S. capacity rose 45% in 2007 and is forecast to nearly triple by 2012. Wind power only represents 1% of the country's electricity, but government and industry leaders want to see that share hit 20% by 2030. This level of wind power will boost the supply of carbon-free energy and create green-collar jobs.[27]

Three types of solar power include **grid-connected photovoltaic** (PV) **cells, off-grid solar systems**, and **solar water heaters**. Approximately 1.5 million homes worldwide have these rooftop solar PVs feeding into the electric grid. *Grid-connected systems* are connected to the electrical grid in an area and can *sell* unused energy into the grid. For example, programs established in Germany, France, Greece, Italy, and Spain allow consumers to sell power to the national grid at roughly twice the rate (40 to 50 European cents) they pay for it.[28]

Off-grid systems refer to solar power cells employed outside of regional or national electricity grids. Many of these systems are installed in developing economies. One application of off-grid systems is the minigrids designed for rural or island areas. Hundreds of these grids operate in Sri Lanka, Nepal, Vietnam, and India. The largest installed user is China with 1.5 million people using these off-grid systems in rural areas. A second off-grid application is the water pumps that are fueled by solar PV cells. More than 50,000 pumps are installed worldwide, and the largest market is India. Off-grid household solar systems represent a third application. More than 2.5 million people receive electricity from solar home systems. In recent years, China, the largest market, has added more than 400,000 home systems.[29]

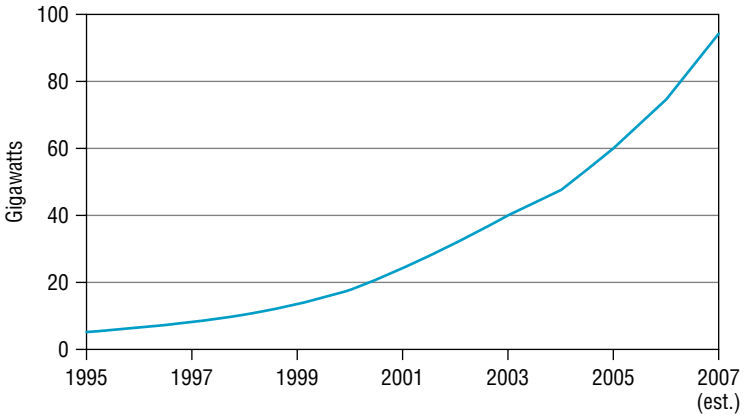

FIG. 4-5 Existing World Capacity for Wind Power

Source: *REN21.2008. Renewables 2007 Global Status Report (Paris: REN21 Secretariat and Washington, DC: Worldwatch Institute). http://www.ren21.net/pdf/RE2007_Global_Status_Report.pdf (accessed August 22, 2008).*

Solar water heaters are heaters that use solar energy to heat water. *Active* heaters use a system of pumps and controls to heat the water, whereas passive heaters do not. Active heaters are more expensive and efficient than passive solar heaters.[30] China is the only major country with a long-term plan for solar water heaters. The country has set goals that would enable one quarter of all Chinese households to use solar water by 2010. Subsidies are employed by countries seeking to establish these devices in national markets. Australia, Austria, Belgium, Canada, Cyprus, Finland, France, Germany, Greece, Hungary, Japan, the Netherlands, New Zealand, Portugal, Spain, Sweden, the United Kingdom, and the United States have established subsidies to encourage solar heater usage. The largest U.S. subsidy was California with a 2007 enactment offering more than $250 million in incentives targeted at 200,000 residents over the next 10 years.[31]

Biofuels refers to a family of fuel products that use some percentage of crops as fuel. Production of biofuels exceeded 53 billion liters in 2007, upto 43% from 2005. *Ethanol* is a fuel made from corn, sugar cane, or wheat that can be used as a substitute for a percentage of fuel in a standard internal combustion engine. Australia, Argentina, Bolivia, Brazil, Canada, China, Colombia, the Dominican Republic, Germany, India, Italy, Malaysia, Paraguay, Peru, Philippines, Thailand, the United Kingdom, the United States, and Uruguay have imposed mandates. These national guidelines typically call for 10 to 15% ethanol in gasoline or 20 to 25% in diesel fuel. Some modified engines provide the ability to use ethanol exclusively. Ethanol production in 2007 represented about 4% of the 1,300 billion liters of gasoline consumed globally.[32]

Biodiesel is a second type of biofuel produced from oilseed crops such as soy or from other vegetable sources such as waste cooking oil. For example, McDonald's converts used cooking oil into biodiesel for delivery trucks in the United Kingdom and Hawaii.[33] Annual biodiesel production increased by more than 50% to more than 6 billion liters in 2006.

Geothermal energy refers to energy available as heat emitted from within the Earth's crust in the form of hot water or steam. It is acquired directly for heating or electricity generation after transformation. Geothermal energy accounts for less than 0.5% of worldwide energy supply, but technological advances are bringing renewed interest to this energy source. More than 2 million ground-source heat pumps are used in 30 countries for heating and cooling of buildings.[34]

At 13% of global fuel usage, biomass represents the largest form of renewable energy in use today. Biomass refers to crop waste, wood, or dung used for home cooking or heating needs. Because of the health consequences associated with biomass, especially from indoor air pollution, efforts are underway to either replace biomass consumption with other forms of energy (e.g., off-grid photovoltaic cells) or to enhance devices employed to process biomass. In developing economies throughout the world, improved biomass techniques are being employed. The stoves are 10 to 50% more fuel efficient, dramatically improve indoor air quality, and reduce greenhouse gases.[35] There are 220 million improved stoves in operation around the world. With 180 million of these stoves, China has supplied 95% of the market for them. By contrast, at 34 million stoves, India has supplied 25% of its market. One third of the African countries have programs in place for enhanced biomass stoves, whereas other countries have promoted access to modern cooking energy for rural populations using traditional stoves.

Although these gains in the use of renewable energy sources are promising, the anticipated 60% increase in demand for energy over the next quarter century is daunting.[36] Fossil fuels will continue to dominate energy consumption, and this consumption will have marked health, environmental, economic, and energy security consequences. The share of renewable energy is growing in absolute terms, but it will remain largely unchanged in the near future. Most long-term projections predict that renewable energy technologies will play a major role in the global energy supply in the second half of the century, but in the first decades the increase in renewable energy will be more modest.

Transportation

Three transportation policies designed to influence energy consumption include cleaner fuels and vehicles, integrated urban road pricing, and bus rapid transit systems.[37] Consider first the cleaner fuels and vehicles.

Cleaner fuels and vehicles In addition to ethanol, compressed natural gas is another alternative to gasoline gaining wider attention in multiple markets. There are currently 11 million propane-powered vehicles operating in the world today.[38] Figure 4–6 indicates, however, that seven countries account for two thirds of consumption. Given that there is great growth potential for other countries to enhance their consumption of this fuel, initiatives are in place in several regions to increase the use of this autogas.[39] Fleet-vehicle purchase mandates or autogas-fuelled public transport program are used in Australia, China, France, Italy, Mexico, and the United States. Canadian legislation provides for mandatory purchases of autogas and other alternative fuels for public fleets. In India, the LP Gas industry succeeded in building very strong relationships with car and three-wheeled vehicle manufacturers. Three-wheeled Asian vehicles are being converted to natural gas to reduce air pollution and enhance energy efficiency.[40] Similarly, Hong Kong has dictated that all new taxis run on liquid propane gas.[41] China's Guangzhou province has converted more than 700 buses to autogas, and 17,000 taxis have been converted to autogas. Similarly, most buses in Beijing run on autogas.[42]

In addition to cleaner fuels, regulations now seek to ensure that vehicles are more fuel efficient. Indeed, automobile fuel economy standards are among the most effective tools in controlling oil demand and GHG emissions from the transportation sector (Table 4–4). As Figure 4–7 illustrates, fuel economy standards for autos have been stagnant in the United States over the past several years. The fuel economy and greenhouse gas emission performance of American cars and light trucks lags behind that of most other nations. The United States and Canada have the lowest standards in terms

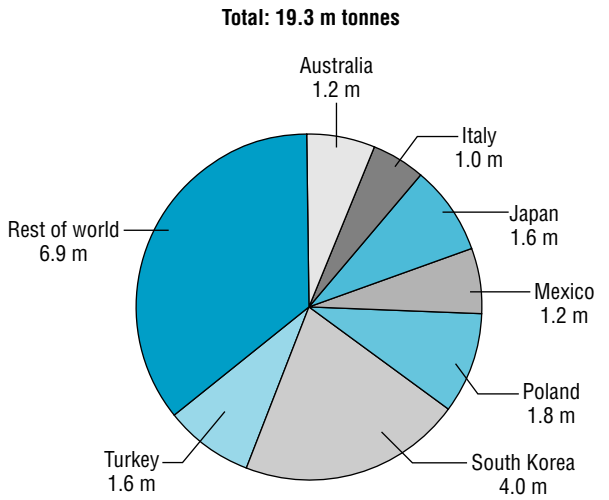

FIG. 4-6 World Autogas Consumption, 2006

Source: *WLPGA/MCH Fundamentals of the World Gas Industry, 2008. Petroleum Economist Ltd.*

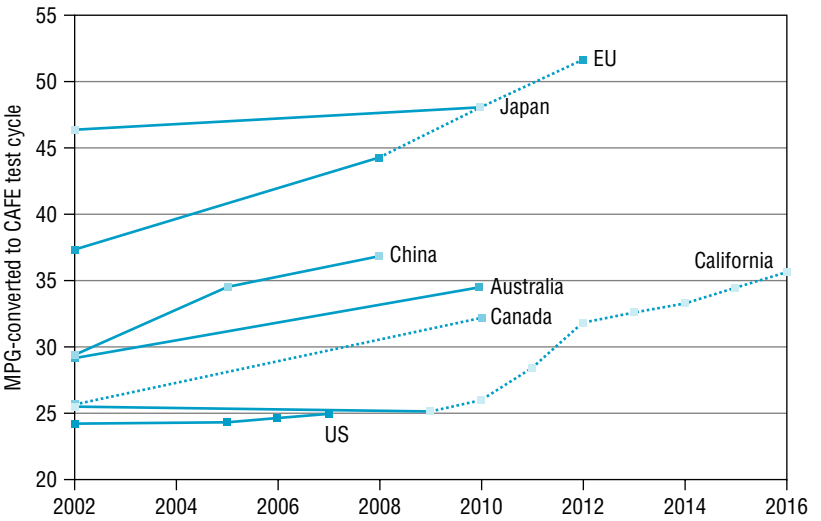

FIG. 4-7 Comparison of Fuel Economy (Corporate Average Fuel Economy—CAFE) and GHG Emission Standards

Source: *Pew Center on Global Climate Change. http://www.pewclimate.org/docUploads/Fuel%20Economy%20and%20GHG%20Standards_010605_110719.pdf (accessed February 26, 2010).*

of fleet-average fuel economy ratings, and they have the highest greenhouse gas emission rates. By contrast, the European Union, Japan, and China have made strides in this area. Japan and the European Union have the most stringent standards in the world. The new Chinese standards are more stringent than those in Australia, Canada, California, and the United States, yet they are less stringent than those in the European Union and Japan. California leads the way in the United States in establishing fuel economy standards. If the California GHG standards went into effect, they would

TABLE 4-4[43] FUEL ECONOMY AND GHG STANDARDS

COUNTRY/ REGION	TYPE	MEASURE	STRUCTURE	TEST METHOD[a]	IMPLEMENTATION
United States	Fuel	mpg	Cars and light trucks	U.S. CAFE	Mandatory
European Union	CO_2	g/km	Overall light-duty fleet	EU NEDC	Voluntary
Japan	Fuel	km/L	Weight-based	Japan 10-15	Mandatory
China	Fuel	L/100-km	Weight-based	EU NEDC	Mandatory
California	GHG	g/mile	Car/LDT1 and LDT2[b]	U.S. CAFE	Mandatory
Canada	Fuel	L/100-km	Cars and light trucks	U.S. CAFE	Voluntary
Australia	Fuel	L/100-km	Overall light-duty fleet	EU NEDC	Voluntary
Taiwan, South Korea	Fuel	km/L	Engine size	U.S. CAFE	Mandatory

[a] Test methods include U.S. Corporate Average Fuel Economy (CAFE), New European Drive Cycle (NEDC), and Japan 10-15 Cycle.
[b] LDT1 and LDT2 are categories of light-duty trucks.

Source: *Pew Center on Global Climate Change.*

narrow the gap between American and EU standards. Despite these potential gains, the California standards remain less stringent than the EU standards.

Integrated urban road pricing *Integrated urban pricing* refers to the use of varied pricing strategies for toll roads based on the time of day one enters a city. These variable pricing strategies are designed to reduce the amount of traffic and limit greenhouse gas emissions. Singapore's automated system charges tolls based on city congestion,[44] and Stockholm uses a similar pricing system in which drivers are charged different amounts depending on the time of day.[45] Bristol, UK; Copenhagen, Denmark; Edinburgh, UK; Genoa, Italy; Gothenburg, Sweden; Helsinki, Finland; Rome, Italy; and Trondheim, Norway also have integrated pricing strategies in place.[46]

Bus rapid transit systems *Bus rapid transit (BRT) systems* are permanently integrated systems of facilities, services, and amenities designed to improve the speed, reliability, and identity of bus transit. In many respects, BRT is rubber-tired light-rail transit with greater operating flexibility and potentially lower capital and operating costs than rail-based systems.[47] In addition, BRTs can be implemented in a fraction of the time needed to set up rail systems. These systems efficiently modify commuting but require investments in bus running lanes, stations, vehicles, routing, services, and fare collection. BRT has been implemented all over the world. In North America, the best examples of BRT include: Boston, Pittsburgh, Miami, Los Angeles, San Fernando Valley, Las Vegas, Houston, Ottawa, Vancouver, and York. Successful BRTs have also been implemented in Curitiba and Sao Paulo, Brazil; Quito, Ecuador; Leon, Mexico; Bogota, Colombia; Sidney, Adelaide, and Brisbane, Australia; Paris, Nancy, and Rouen, France; and Amsterdam and Eindhoven, Holland.[48] BRT offers a cost-effective way to employ rapid transit operating as rapidly as possible with the least amount of funds, and it also preserves options for latter expansion and upgrading.

Buildings and Construction

Across the globe, 30 to 40% of all energy is consumed in buildings, and the lion's share of this consumption is burned for heating, cooling, lighting, and appliances during the operational phase.[49] Low-energy construction saves money, the climate, and human health.

The construction, maintenance, and refurbishment of buildings is managed by a complex network of stakeholders. Our focus is on the role that government plays in pursuing sustainable buildings. **New construction** represents an opportunity to use technology to develop, install, and maintain component parts that conserve energy and use renewable energy resources. For example, the city of Pune, India, has established an efficient energy housing program that incorporates solar and wind energy, solid and wastewater recycling, and construction materials. The program outlines guidelines for eco-construction and develops financing mechanisms for eco-housing. In addition, eco-housing certificates are issued that result in reduced taxes and promote additional eco-housing development. This program has increased Indian interest in improving environmental facets of construction.[50]

The Landskrona, Sweden, new apartment project is another example of new construction that lowers energy consumption. This southern Swedish program involved the development of 35 new rental apartments. These buildings do not use conventional heating (i.e., no radiators or under-the-floor heating systems) but rely on mechanical ventilation systems with heat recovery. These apartments yield savings of 40 to 70 kilowatt hours per square meter per year over conventional apartments.[51]

Old construction is another opportunity to raise fuel efficiency. Consider, for example, the multifamily dwellings constructed by the Soviets. In 1996, Lithuania embarked on an effort to lower the fuel consumption associated with these buildings. The three primary priorities of these programs are to ensure efficient energy use, sustainable management, and modernization of housing. The goal is to refurbish 70% of housing built before 1993 by 2020. Achievement of this goal will result in savings of €55 million and a reduction of 365,500 tons of carbon emissions.[52]

The citizens of Gårdsten, Sweden, are engaged in similar efforts to raise the performance of existing buildings. Multifamily dwellings have been equipped with prefabricated solar collectors used to heat water for the apartments. In addition, external walls have been insulated with an air gap between the insulation and the wall. These modifications, along with thermal insulation, have reduced energy consumption by 30%.

One benefit of the efforts to enhance sustainability in the developing world is the potential for carbon offsets with mature economies. For example, Cape Town, South Africa, is retrofitting 2,300 low-income housing units with technological enhancements such as energy-efficient lighting and solar water heaters.[53] South Africa benefits from this program through reduced greenhouse emissions, improved health, and new employment opportunities. The project will generate 130,000 tons of carbon credits over its 21-year lifetime. The first 10,000 tons have been sold to the United Kingdom.[54]

The Chinese market represents a significant opportunity to influence sustainability. At the national level, the Chinese government is committed to investing US$193 billion to make buildings more efficient by 2020. An important part of this initiative is to reduce markedly the country's reliance on coal. Government buildings are setting the standard for sustainability. The country's 600 million square meters of government office space represent 6% of the total area of civic buildings. Adding fuel efficiency to these buildings will save the equivalent of 18 million tons of coal. It will, however, take 5 to 10 years to change societal behavior and improve energy efficiency.[55] At the provincial level, the Inner Mongolian and Qinhai Provinces subsidize home expenditures for solar equipment. The program will provide electricity for 23 million people in the region by making use of renewable resources like solar PV and wind generation.[56] At the local level, Shanghai has established a certification and labeling program for energy-efficient housing. Participants enjoy favorable tax policies and have access to special funding for the support of energy-efficient buildings.

Appliances

At 29% of global spending on energy, the household sector represents the second largest contributor to energy spending. One primary area of concern is the use of appliances. Consumers are using more appliances today, and many of these products use more energy than their predecessors did. Consequently, the demand for energy for appliances is the most rapidly growing part of the household sector, with a 57% increase in consumption since 2005. Appliances overtook water heating as the second most energy-consuming category in the late 1990s and now account for 21% of total household energy consumption.[57] Large appliances include refrigerators, freezers, washing machines, dishwashers, and televisions. Since 1990, the share of total energy use by all of these appliances except televisions has decreased in mature economies. The average unit's energy consumption has declined even though the refrigerators and freezers have become larger. Energy efficiency gains for televisions have been outstripped by the consumer trend toward larger screens, which use more energy. Total energy consumption in the EU15 fell for refrigerators and washing machines. For other appliances, improved efficiency has been more than offset by higher levels of ownership and use.[58]

The United Nations works in partnership with the *Collaborative Labeling and Appliance Standards Program* (CLASP) to reduce energy consumption associated with appliance use. Established in 1999 in the United States, CLASP became a global nonprofit corporation in 2005. It is governed by nine directors from six countries on four continents. Working in conjunction with government officials responsible for standards and labeling, CLASP assists in the development of a testing capability for a product and assists in analyzing and setting standards. CLASP also designs and implements label programs along with communications programs designed to inform consumers about product energy usage (Figure 4–8).

FIG. 4-8 Energy Star and EnergyGuide Labels

Source: © Art Directors & TRIP/Alamy

Source: © Federal Trade Commision, www.ftc.gov

CLASP also provides oversight and evaluation to ensure the integrity of the standards. For example, washing machines sold in the United States must meet standards for energy supply, water pressure, agitation and speed settings, and other standards. By coordinating the development of these standards with CLASP, the United States has the ability to compare product efficiencies with those operating in other countries. U.S. law also requires that new appliances display a label that helps consumers compare energy efficiency among similar products. In 1980, the Federal Trade Commission began requiring that *EnergyGuide* labels be placed on all new appliances. These labels indicate a range of energy use among models in a product class, and they provide estimates of the annual cost of operation of a product.

In addition to the EnergyGuide labels, a subset of products in a category can display the **Energy Star** label. This label, which was originally developed in the United States for the computer industry, is now applied to 50 product groups sold in the United States, Canada, Japan, Australia, Taiwan, the European Union, and the European Free Trade Association. The label indicates that the product possessing it is one of the most efficient products in the class. The percentage of products that earn the Energy Star label varies by product class. The Energy Star-qualified appliances in the washing machine group are those that use 10 to 50% less energy and water than standard models.[59] By contrast, televisions sold in the United States that display the Energy Star label use 30% less energy than standard units.[60]

The use of standards to facilitate product comparison offers many advantages. Over the last 10 years, CLASP has assisted with the implementation of 21 new minimum energy performance standards, energy efficiency endorsement labels, and energy information labels that will save 250,000 tons of carbon dioxide by 2014.[61] Participating countries benefit from enhanced institutional capacity for implementing standards and labeling programs, increased production of energy-efficient products by manufacturers, and improved average energy efficiency of appliances. Moreover, these standards yield significant reductions in electricity consumption as well as lower energy-related emissions of greenhouse gases.[62]

C. Environmental Action Designed to Reduce Human Influences on the Atmosphere

Air Pollution

International action focused on controlling air pollution is implemented on a regional basis in Europe, North America, and Asia. In 1947, the United Nations established the United Nations Economic Commission for Europe (UNECE) as one of five regional commissions. The UNECE establishes standards to facilitate international cooperation within and outside the region.[63] Since 1979, this group has developed the Convention on Long-range Transboundary Air Pollution. This treaty has been extended via eight protocols identifying specific measures to be taken by parties to reduce air pollution. Here is a brief synopsis of these protocols:

1. *The 1984 Geneva Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe*. This protocol provides for international cost sharing of monitoring programs. The protocol calls for collection of emission data for SO_2, NO_x, VOCs and other air pollutants; air and precipitation quality measurement; and modeling of atmospheric dispersion. About 100 monitoring stations in 24 countries participate in the program.[64]

2. *The 1985 Helsinki Protocol on the Reduction of Sulfur Emissions*. The Helsinki protocol sought sulfur reductions of at least 30% over 1980 levels. The 21 parties to this protocol had reduced 1980 sulfur emissions by more than 50% by 1993.[65]
3. *The 1988 Sofia Protocol Concerning the Control of Emissions of Nitrogen Oxides*. The Sofia protocol seeks a reduction in emissions of NO_x of 9% compared to 1987. Nineteen of the 25 parties to the protocol have reached the target emissions at 1987 (or 1978 for the United States) levels of reduced emissions.[66]
4. *The 1991 Geneva Protocol Concerning the Control of Emissions of Volatile Organic Compounds*. This directive seeks a 30% reduction in emissions of volatile organic compounds (VOCs) by 1999 using a year between 1984 and 1990 as a basis.[67]
5. *The 1994 Oslo Protocol on Further Reduction of Sulfur Emissions*. This protocol augments the 1985 Helsinki directive by adding criteria that led to a differentiation of emission reduction obligations of parties to the protocol.[68]
6. *The 1998 Aarhus Protocol on Persistent Organic Pollutants (POPs)*. The goal of this protocol is to eliminate discharges of POPs. The protocol bans the production and use of some products outright (e.g., chlordane), limits the use of POPs and schedules them for elimination at a later stage (e.g., DDT).[69]
7. *The 1998 Aarhus Protocol on Heavy Metals*. This protocol calls for reduced emissions for cadmium, lead, and mercury beyond their levels in 1990. It also requires participating parties to phase out leaded gasoline.[70]
8. *The 1999 Gothenburg Protocol to Abate Acidification, Eutrophication, and Ground-level Ozone*. This protocol sets limits for sulfur, NO_x, VOCs, and ammonia. When the protocol is fully implemented, Europe's sulfur emissions will be cut by at least 63%, NO_x emissions by 41%, VOC emissions by 40%, and ammonia emissions by 17% compared to 1990.[71]

These protocols offer pollution standards adopted by countries outside of Europe. Canada and the United States have participated in several of these protocols. Both countries have ratified the 1984 Geneva Protocol, the 1988 Sofia Protocol, and the 1998 Heavy Metals Protocol. Canada has also ratified the 1985 Helsinki Protocol and the 1998 Aarhus Protocol for heavy metals, whereas the United States has ratified the 1999 Gothenburg Protocol.

In addition to the ratification of these protocols, the United States has been working to enhance air quality since the enactment of the Clean Air Act of 1970. The U.S. Environmental Protection Agency (EPA) sets national air quality standards for common air pollutants (carbon monoxide, ozone, lead, nitrogen dioxide, particulate matter, and sulfur dioxide). As a result, emissions of each of these six pollutants have dropped more than 32% since 1990.[72] The Clean Air Act further required the EPA to issue a series of rules to reduce pollution from automobiles. Emissions from new cars purchased today are well over 90% cleaner than new vehicles purchased in 1970.[73]

In 1990, a new Clean Air Act introduced a nationwide approach to the reduction of acid rain. The law is designed to reduce acid rain and improve public health by reducing emissions of sulfur dioxide and nitrogen oxides. The program sets a permanent limit on the total amount of sulfur dioxide emitted by electric power plants nationwide. As of 2005, emission reductions were 41% below 1980 levels.[74]

Asian countries have also enacted policies to limit air pollution. The Association of Southeastern Nations (ASEAN) has adopted a Haze Fund designed to coordinate response to forest fires and the resulting smoke and fog.[75] In China, a country with tremendous need to curb pollution, environmental law is underdeveloped and

neglected.[76] Nevertheless, during the current Five-Year Plan (2006-2010), China will invest 1,375 billion yuan (US$169.5 billion) in environmental protection. Substantial portions of these funds will address air pollution and water shortages.[77]

Ozone

The United Nations and affiliated countries have been taking action to reduce ozone depletion for more than 20 years. In 1987, the United Nations developed the Montreal Protocol.[78] This directive and other regulations banning ozone-depleting substances have reversed the destructive trend toward ozone depletion. CFCs previously used in refrigerants, blowing foams, and solvents have been temporarily replaced with hydrofluourocarbons (HFCs). Although HFCs also contribute to ozone depletion, their influence is substantially lower (88–98% less effective ozone depletion) than that of CFCs. The UN directives, however, call for the long-term elimination of these chemicals as well. HFCs are also used as substitutes for CFCs. Although these chemicals do not deplete the ozone, they contribute to global warming. Two bromide-based halogens, halon-1211 and halon-1301, represent a substantial portion of bromine from all source gases (see Figure 3–8). Despite the elimination of production in developed nations in 1994, emissions of these gases will remain high into the 21st century due to their long lifetimes and continued release.[79]

Despite the fact that bromide-based emissions continue to be problematic, there is evidence that the Montreal Protocol is working. The concentrations of halogens peaked in the lower atmosphere in 1995 and in the stratosphere in 2001.[80] Recent research indicates evidence of a decrease in the atmospheric burden of ozone-depleting substances in the lower atmosphere. There is also evidence of some early signs of the expected stratospheric ozone recovery.[81] Given that ozone-depleting gases typically last 40 to 100 years in the atmosphere, full recovery is not expected before 2070. Nevertheless, failure to continue to comply with the Montreal Protocol could delay or prevent recovery of the ozone layer.[82]

D. Environmental Action Designed to Reduce Human Influences on Water

Consumption simultaneously influences multiple factors associated with water. We examine three related aspects of water. These include the availability of clean drinking water, the impurities in water, and the oceans and fisheries as bodies of water.

Access to Clean Drinking Water

Efforts to increase the accessibility of freshwater are underway in many parts of the world, yet one sixth of the world's population still does not have access to clean drinking water.[83] The availability of freshwater is increasingly a more significant problem across the globe, but at present it is most pronounced in Asia and Africa.

Over the last decade, Asia has witnessed overall progress in the availability of drinking water (see Figure 4–9). Nevertheless, 655 million people in the region still lack access to safe water. South Pacific states have not made any progress, and conditions in Central Asian countries actually deteriorated. In many megacities, up to 70% of citizens live in slums and generally lack access to improved water and sanitation.

In northeastern Asia, China is developing the Three Gorges Dam. This dam offers a number of environmental benefits but also challenges biodiversity. The

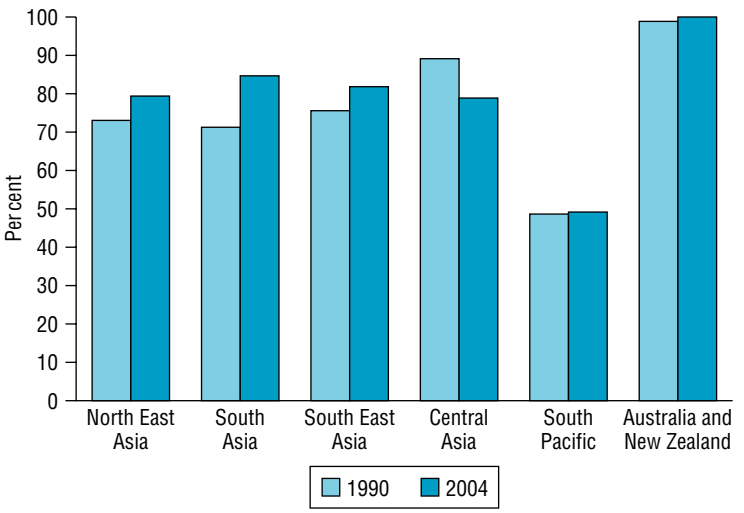

FIG. 4-9 Access to Safe Drinking Water as a Percentage of the Total Population

Source: United Nations Environment Programme, Global Environment Outlook GEO4. (*Valletta, Malta: United Nations Environment Programme, 2007), p. 572.*

dam provides the potential for cleaner drinking water and reduces reliance on coal (and its inherent pollutants) for energy. In addition, China is spending 40 billion yuan (US$5 billion) between 2001 and 2010 on 150 sewage treatment plants and 170 urban garbage disposal centers. This investment is made to prevent water pollution in the Three Gorges Dam and the Yangtze River.

Regrettably, progress toward increased availability of drinking water in Africa has been modest. Although there has been some success such as the shared watercourse systems in the Southern African Development Community (SADC), officials in many countries work in very difficult conditions with minimal resources at their disposal. These resource constraints are due to poor economic conditions as well as low budget allocations to water. Government departments are underresourced, and the number of professionals employed in the water and sanitation sector in public service is inadequate.[84]

Although there are ongoing efforts on each continent to enhance the quality of freshwater, more work is needed to secure suitable drinking water. If appropriate action is not taken, environmental science projects that the majority of the world population will live in conditions of very low water availability by 2025.[85] Science underscores the need for a drastic decrease in water consumption, especially in irrigated land use and industry. In addition, environmental researchers call for reduction of wastewater discharges into the water supply, long-term river runoff regulation, and the redistribution of water resources across territories.[86]

Water Impurities

Whereas the prior section examined the general level of freshwater availability, this section addresses procedures employed to reduce specific impurities in the water supplies. The **World Health Organization** (WHO) has established guidelines designed to limit the impurities in the water supply. The guidelines offer health-based targets implemented by national water authorities. The guidelines indicate generally acceptable levels of biological and chemical (i.e., anthropogenic) water contaminants

for water suppliers. For example, the WHO recognizes that manganese in water supplies causes an undesirable taste in beverages and stains laundry. Consequently, the guidelines call for a maximum of 0.4 mg/liter in the water supply. The WHO guidelines also offer background information on microbial, chemical, and radiological aspects of contaminants. In addition, the health-based guidelines indicate procedures for monitoring of control measures for drinking water safety as well as independent surveillance systems to ensure that water supplies remain healthy.

Although the WHO provides the guidelines, the determination of water quality is administered on a national and regional basis. The quality of drinking water is an increasing concern in every region. For instance, the European Union introduced the Water Framework Directive in 2000 with the goal that all water bodies attain good ecological status by 2015. Although there are many international European water agreements, there has been a significant decline in the level of water quality monitoring in parts of Central and Eastern Europe over the last decade.[87] The United States experienced more than 250 disease outbreaks and almost 500,000 cases of water-borne illness from 1985 to 2000. Consequently, the Safe Drinking Water Act has been modified on several occasions to curb exposure to microbial contaminants and disinfectants. In addition, new standards have been developed to eliminate exposure to metals such as arsenic.[88]

Water contaminants continue to be problematic in Asia despite multiple efforts to enhance water quality. There have been attempts to reform the water and sanitation sector in South Asia and Southeast Asia, including large-scale subsidization of water for the poor. For instance, Laos is developing the infrastructure to ensure greater access to safe water and sanitation, especially for the rural population. Similarly, Singapore is recycling wastewater and using new filtration technology to bring it to acceptable drinking standards.[89]

In Africa, suitable water and sanitation facilities have been extended to many more people during the past decade, but there is a strong need to increase the access to clean water and sanitation.[90] South Africa has passed a National Water Act designed to protect ecosystems and enhance the quality of water.[91] Nevertheless, more regulation is needed to ensure that citizens have access to clean drinking water and sanitation. Among countries with available data, almost half had less than 50% coverage for sanitation. Ten countries (Angola, Burkina Faso, Chad, the Democratic Republic of the Congo, Eritrea, Ethiopia, Madagascar, Mauritania, Rwanda, and Sierra Leone) have less than 50% availability of suitable drinking water and sanitation.

Oceans and Fisheries

International governance of oceans is coordinated via the United Nations Convention on the Law of the Sea. This law outlines rights and obligations of countries, and it further provides the international basis for protection and sustainable development of the marine and coastal environment. The Convention entered into force in 1994 and has been ratified by 135 nations. The past 10 years has witnessed substantial progress toward an integrated approach to coastal management. Increasingly, nations are codifying requirements for coastal management. Standards developed by the United Nations and the World Bank provide direction in the development of these regulations. The 1995 Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-based Activities provided additional incentive to develop methods for preventing the degradation of the marine environment. GPA provides conceptual and practical guidance to national water authorities and facilitates cooperation among nations.[92]

Although the level of cooperation among nations has increased, estimates indicate that at least 60% of world fisheries are either fully exploited or overfished. The Food and Agriculture Organization (FAO) of the United Nations Code of Conduct for Responsible Fisheries has influenced many countries to modify fisheries laws. This UN organization developed the Code of Conduct for Responsible Fisheries in 1995. This code is the foundation for promotion of sustainable fisheries and aquaculture. The FAO also has outlined international plans of action to improve shark management and to control fishing. Despite these regulations, illegal, unregulated, and unreported fishing remain severe problems affecting world fisheries.

E. Environmental Action Designed to Reduce Human Influences on Land

Urban Expansion

The year 2007 marked the first year that the population in urban settings exceeded the rural population.[93] Urban expansion is an issue on every continent, but there are varying levels of response to this issue. Interestingly, in Latin America, countries with the lowest percentages of urban citizens are witnessing the fastest urbanization rates. The urban growth rates in Paraguay, Chile, and Bolivia are now faster than in Argentina, Ecuador, and Chile.[94] Africa is the least urbanized inhabited region, but it has the world's highest rate of urbanization.

Increasing urbanization is an issue on every continent, but the primary impetus for change has been in mature economies. The U.S. EPA funds the **Smart Growth Network**, an organization focused on enhancing the quality of living conditions in cities. *Smart growth* refers to a set of policy options that relates the reshaping of urban growth to transportation priorities.[95] This network seeks to enhance urban lifestyles by promoting a range of housing opportunities and walkable neighborhoods. It encourages community and stakeholder collaboration and fosters attractive communities that make fair development decisions. In addition, it seeks to provide transportation alternatives within cities and promotes preservation of open space, farmland, and natural beauty.

In contrast to urban sprawl that follows freeways, smart growth relies on compact urban development and revitalization of older areas in cities in conjunction with renewed public transit systems. Recent evidence indicates that adoption of smart growth principles and guidelines reaps benefits for cities. Research conducted in 44 cities around the world (12 each from the United States and Europe, 6 each from Canada and Australia, and 8 Asian cities) indicate that smart growth is becoming an international trend. Urban districts are beginning to reverse trends toward sprawl, and population densities are increasing or have stopped in many cities. City governments and concerned citizens are revitalizing older areas more than building on the urban fringe.

Land Degradation

Degradation of land is related to several other facets of the environment, especially water quality and biodiversity. One of the primary issues on land degradation is the international movement of hazardous materials. The *Basel Convention on the Control of the Trans-boundary Movement of Hazardous Wastes and Their Disposal* was adopted in 1989 and entered into force in 1992. This convention

was created to prevent the economically motivated dumping of hazardous wastes from richer to poorer countries. The *Basel Ban Amendment*, adopted in 1995, prohibits all exports of hazardous wastes from the OECD, EU, and Liechtenstein to all other parties to the convention. The United States is the only OECD country that has not ratified the Basel Convention or the Basel Ban Amendment. China, India, Myanmar, and Pakistan become the home of more than 90% of 20 to 50 million tons of electronic waste produced each year.[96] Export of e-waste to these countries is a violation of the Basel Convention and the Basel Ban Amendment. In other parts of Asia, Japan and South Korea are lowering waste generation through reduced use of natural resources in production and more sustainable consumption.

The New Partnership for African Development (NEPAD) program addresses soil erosion, salinization, declining fertility, soil compaction, and pollution on the continent. Through a network of regional organizations, NEPAD promotes sustainable land use, rational use of rangelands, sustainable agriculture, and integrated natural resource management.[97] Similar problems plague West Asia where poorly managed irrigation systems are associated with higher levels of salinity. Although there are efforts to improve degraded lands, most of this action is focused on 16% of the land mass located in the Arabian Peninsula and Mashriq.

In the European Union, reduction in levels of industrial production and agricultural intensity limits the extent of land degradation. Nevertheless, Eastern Europe faces threats due to Soviet-era accumulation of hazardous materials. These materials include radioactive waste, military and mining waste, and obsolete pesticides (containing persistent organic pollutants). Because funds to dispose of this material are lacking, the environment remains at appreciable risk.

Deforestation and Desertification

Recognizing the worldwide concerns about deforestation, the United Nations has developed some nonbinding instruments for the management of forests. The UN calls for the reverse of loss of forest cover worldwide through sustainable forest development and for enhancement of forest-based economic, social, and environmental benefits. In addition, it calls for increases in the area of protected forests as well as increases in funding for sustainable forest management.[98] Despite this initiative, subregional issues continue to limit the amount of forestation. For example, the European Union has adopted a sustainability strategy for forest management; Eastern Europe continues to try to limit illegal logging as well as human-induced forest fires. Deforestation is rampant in the Middle East, yet the balancing of this activity with reforestation in other areas has resulted in no major changes in the level of forestation over the past 15 years.

Efforts to curb desertification recognize that the increased frequency and severity of droughts (due to climate change) will likely exacerbate desertification. Consequently, the United Nations Convention to Combat Desertification offers a platform for mitigation of this issue. This convention outlines necessary financing, information, and technology to reduce desertification, and it also outlines national action programs.[99]

Implementation of the UN efforts to combat desertification occurs on a regional level with the greatest attention focused on Africa, Asia, the Northern Mediterranean region, Central and Eastern Europe, Latin America, and the Caribbean. Given that two thirds of Africa is desert or drylands, its implementation plan is the most detailed of all regions. The plan calls for adoption on a national basis of legal, political, economic, financial, and social measures to limit desertification.[100]

Asia faces similar problems due to the high percentage of land that is desert. About 27% of China is desertified, and nearly 400 million people live in these areas. China has responded to this environmental threat by passing laws and drawing up a national plan to limit desertification. In the Northern Mediterranean, land degradation is often linked to poor agricultural practices. Thus, Greece, Italy, Portugal, Spain, and Turkey are launching a subregional program for scientific cooperation, exchange of information and documentation, and organization of regional training courses. Similarly, countries in Central and Eastern Europe are coordinating efforts in scientific research, data management, information exchange, training, drought mitigation, and disaster preparedness. The Latin American regional plan outlines the need to eliminate unsustainable practices such as excessive irrigation and inappropriate agricultural practices, inadequate legal issues, inappropriate use of soil, fertilizers and pesticides, overgrazing, and intensive exploitation of forests.

F. Environmental Action Designed to Reduce Human Influences on Biodiversity

Biodiversity concerns variation among species of plant and animal life. In 1992, members of the United Nations signed the *Convention on Biological Diversity*. This document sought to conserve biodiversity, promote sustainable use of the components of biodiversity, and share the benefits of utilization of genetic resources in a fair manner. The Convention offers guidance based on the precautionary principle that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat. The convention recognizes that substantial investments are required to conserve biological diversity. Current evaluations of progress of the convention indicate strong increases in the coverage of protected areas for various species. The abundance of species and respected habitats, however, is decreasing. Moreover, threatened species face greater risks than in previous eras.

The Convention on Biodiversity provides guidelines for implementation on a regional or national level. Due in part to rapid development in the region, the Asia Pacific region has encountered tremendous pressure on ecosystems over the past two decades. Asian countries participate in protection of coastal ecosystems by affiliation with one of four Regional Sea Action Plans: East Asia, Northwest Pacific, South Asia, and the Pacific. Despite this affiliation, East Asia and South Asia discharge more than 85% of their wastewater directly into the sea. In the South Pacific, local communities are collaborating through locally managed marine areas designed to protect coastal areas.

The EU initiatives to deter biodiversity loss are more stringent than those established by the UN convention. The Pan-European Ecological Network (PEEN) is a nonbinding framework that promotes cooperative action across Europe, contributing to the evolving international process of developing a stronger strategic component to nature conservation in Europe.[101] The EU Commission on a European Biodiversity Strategy seeks to anticipate, prevent, and attack causes of reduction or loss of biodiversity at the source. It focuses on the reversal of present trends in biodiversity reduction or losses. It also provides a clearinghouse that facilitates public access to information relevant for biodiversity.[102]

Protection of biodiversity is also a vital concern in Latin America. Over the past 15 years, the amount of protected marine and terrestrial land has nearly doubled.

The Mesoamerican Biological Corridor is a nearly 10-year-old project designed to support biodiversity in Mexico, Belize, Guatemala, Honduras, Nicaragua, Costa Rica, and Panama.[103] Similarly, a program designed to conserve the Brazilian rain forest is a joint undertaking of Brazil and the international community that seeks to find ways to conserve the tropical rain forests of the Amazon and Brazil's Atlantic coast.[104]

Although there has been some progress toward biodiversity targets, the UN recognizes that much work is needed to achieve a significant reduction of the current rate of biodiversity loss. To limit biodiversity loss, it is imperative to improve agricultural efficiency and plan for agricultural expansion. Furthermore, the demand for meat by the more affluent sectors of society should be lowered and overfishing should be eliminated. Biodiversity should be integrated with trade liberalization decisions, and it should be integral to poverty-reduction strategies. Finally, regulators should recognize that biodiversity will be better protected through actions that are justified on their economic merits.[105]

G. The Role of Energy Conservation Efforts to Limit Climate Change and Pollution

Energy conservation refers to efforts to limit the amount of resources employed in consumption. Conservation efforts provide a complement to the Kyoto Protocol. **Efficient usage** examines the extent to which organizations and individuals engage efforts to **reduce, reuse, or recycle** resources. Although this strategy is often associated with reductions in pollution, efficient energy use also has important implications for climate change. Since a substantial amount of resources are employed to refine and process materials consumed by individuals, firms, and other organizations, reductions in the amount of material required limit the need for greenhouse gas emissions. For example, use of hybrid automobiles reduces the need for fossil fuels by 30 to 60%.[106]

Reuse of material also constrains energy requirements because there is limited need to process materials that are reused. For instance, Xerox developed a program in 1995 that used components from leased copiers as high-quality, low-cost parts for new machines. This strategy enables Xerox to provide lease customers with the latest technologies while also reducing production costs.[107] Similarly, recycled materials gain economic advantages over new materials to the extent that the costs to process the recycled materials are lower than the costs for new resources. For example, excess aluminum from Ford's Chicago stamping plant is recycled by Alcan. This process requires 5% of the energy used to produce the primary aluminum and reduces GHG emissions by 95%.[108]

Most developed countries promote recycling. For example, Figure 4–10 outlines the sources of waste materials in the United States in 2007. The amount of municipal solid waste (MSW) recovered in 2007 was 33% (85 million tons) of the total MSW generated. American recyclers increasingly pass their materials on to overseas buyers. China, India, and other Asian economies are propelling the markets for recycled paper, metals, and plastics to near-record prices. In addition, they provide a needed outlet for other goods such as newsprint.[109]

Although efforts to reuse–reduce–recycle are promoted in multiple nations, several issues limit the viability of these programs. Economic analyses of household recycling indicate that it usually does not pay for itself. Research illustrates that the typical costs of processing reclaimed materials exceed the revenue generated from

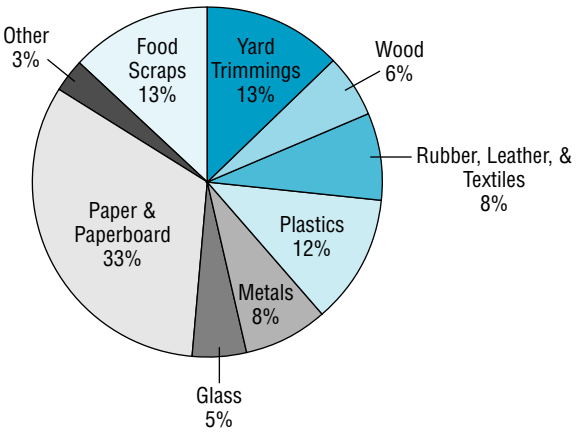

FIG. 4-10 U.S. Recycling Rates as a Percentage of Total Municipal Solid Waste Recycling in 2007

Source: *United States Environmental Protection Agency (2008)*, Municipal Solid Waste in the United States: 2007 Facts and Figures, *p. 6, http://www.epa.gov/osw/nonhaz/municipal/pubs/msw07-rpt.pdf. (March 1, 2010)*

the reclaimed goods.[110] Second, electronic equipment and computers that contain lead, mercury, chromium, cadmium, and other toxic material are an increasing problem for landfills. These products may also contain glass, copper, silver, and gold that raise concern for disposal when the product is no longer useful. In the United States, only 10% of the 2.5 million tons of electronic waste is recycled, yet 70% of the heavy metals in landfills are from this waste.[111]

International conservation efforts are using legislation to control the components that go into products as well the producer's responsibility for a product beyond its useful life. In 2003, the EU also adopted a Directive on Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment. This policy bans the use of lead, mercury, cadmium, hexavalent chromium, and brominated flame retardants used in plastics. China has also adopted regulations banning the same six substances, beginning in 2006, thus ensuring that Chinese products meet EU requirements.[112] Together, this action reduces the amount of hazardous material discarded in landfills. Legislation is also being enacted that requires recycling at the end of the useful life for computers and appliances.[113] In 2003, the European Union adopted the Waste Electrical and Electronic Equipment (WEEE) Directive that requires producers to take responsibility for recovering and recycling electronic waste without charge to consumers. This directive not only promotes recycling and reduces landfill disposal and incineration, but it also is an incentive to producers to design products in ways that reduce waste and facilitate recycling. Dell computers has been active in its efforts to address these requirements. In 2006, the company developed a program that enabled consumers across the globe to return Dell computers, printers, and monitors at no cost.[114]

There are several important business consequences associated with reduce–reuse–recycle strategies.[115] In many cases, organizations must attend to conservation efforts because of legal requirements. Organizations cannot be reckless with hazardous waste, and most countries have laws dictating how these materials may be stored. For example, European Union members must adhere to union legislation for the disposal

of hazardous waste.[116] Second, reductions in the amount of consumption and waste lower the firm's overall costs. Shell Oil lowers its waste levels by pumping carbon dioxide into 500 Dutch greenhouses. This action reduces emissions by 325,000 tons per year and saves greenhouses from having to burn millions of cubic meters of gas needed to produce carbon dioxide.[117] Thus, costs are reduced for Shell and the greenhouses.

Although there are some lingering issues with the success of reuse–reduce–recycle strategies, they remain important mechanisms that limit climate change and reduce pollution. Consequently, in the coming chapters addressing various types of consumers, we incorporate discussion of efficient usage into analyses of household, services, transportation, and manufacturing consumers.

Summary

A. Identify Environmental Action Designed to Reduce Climate Change

The Kyoto Protocol outlines national efforts to reduce or limit greenhouse gases. The protocol introduced three market mechanisms (emissions trading, clean development mechanism, and joint implementation) that enable countries to engage in international commerce to meet emission targets. These mechanisms stimulate sustainable development via the transfer of technology and investment, and they encourage the private sector and developing countries to contribute to emissions reductions. They help countries to meet their commitments by cost effectively removing GHGs from the atmosphere in other countries.

B. Understand Efforts to Influence the Supply and Demand for Energy

Renewable energy sources provide contributions to the supply of energy. To the extent that these sources are employed as substitutes for fossil fuels, the environment does not encounter the negative consequences of oil or other fossil fuel consumption. Renewable energy sources will increase throughout the world, but the demand for energy will also continue to rise. Some of the greatest opportunities for energy conservation lie in the transportation, construction, and appliance industries.

C. Environmental Action Designed to Reduce Human Influences on the Atmosphere

International action focused on controlling air pollution is implemented regionally in Europe, North America, and Asia. The United Nations Economic Commission for Europe establishes standards to facilitate international cooperation within and outside the region. This group has developed the Convention on Long-range Transboundary Air Pollution, a document that has been extended via eight protocols identifying specific corrective measures.

D. Environmental Action Designed to Reduce Human Influences on Water

Efforts to increase the accessibility of freshwater are underway in many parts of the world, yet one sixth of the world's population still does not have access to clean drinking water.[118] The availability of freshwater is increasingly a more significant problem across the globe, but at present it is most pronounced in Asia and Africa. Over the last decade, Asia has witnessed overall progress in the availability of drinking water. Nevertheless, 655 million people in the region still lack access to safe water. Progress toward increased availability of drinking water in Africa has been modest. Government departments are underresourced, and the number of professionals employed in the water and sanitation sector in public service is inadequate.

E. Environmental Action Designed to Reduce Human Influences on Land

Increasing urbanization is an issue on every continent, but the primary impetus for change has been in mature economies. The Smart Growth Network, an organization focused on enhancing the quality of living conditions in cities, has established a set of policies designed to reshape urban growth and transportation priorities. This network seeks to

enhance urban lifestyles by promoting a range of housing opportunities and walkable neighborhoods. It encourages community and stakeholder collaboration and fosters attractive communities that make fair development decisions.

F. Environmental Action Designed to Reduce Human Influences on Biodiversity

Biodiversity concerns variation among species of plant and animal life. The United Nations has developed a convention designed to conserve biodiversity, promote sustainable use of the components of biodiversity, and share the benefits of utilization of genetic resources in a fair manner. The convention offers guidance based on the precautionary principle that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat. The convention recognizes that substantial investments are required to conserve biological diversity.

G. The role of Energy Conservation Efforts to Limit Climate Change and Pollution

Energy conservation refers to efforts to limit the amount of resources employed in consumption. Efficient usage examines the extent to which organizations and individuals engage in efforts to reduce, reuse, or recycle resources. This strategy is often associated with reductions in pollution, but efficient energy use also has important implications for climate change. Because a substantial amount of resources are employed to refine and process materials consumed by individuals, firms, and other organizations, reductions in the amount of material required limit the need for greenhouse gas emissions.

Keywords

biodiesel, 69
biofuels, 69
carbon offsets, 63
certified emission reduction, 63
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Questions

1. What sectors of the economy might show favor or disdain for the Kyoto Protocol?
2. How does the Kyoto Protocol facilitate the exchange of emission credits?
3. Why is it important for multinational organizations to be involved in efforts to confront climate change?
4. What is the current role of renewable energy as a source of energy for residential and commercial use?
5. What are the primary types of solar power that are being used in residential settings?
6. The owner of a 40-year-old home claims that sustainable business practices are only important for new housing. How might you respond to such a comment?
7. What are the governing rules concerning air quality, and how effective have they been?
8. What is the magnitude of the clean drinking water and sanitation problem on the globe, and to what extent is this a regional issue?
9. Why is the United Nations concerned about biodiversity, and what efforts has it taken to limit the number species on the endangered list?
10. How are efforts to "reduce, reuse, and recycle" related to climate change?

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