BASIC CONCEPTS OF SUSTAINABLE DEVELOPMENT FOR BUSINESS STUDENTS

Peter N. Nemetz, Ph.D.
Professor of Strategy and Business Economics
Faculty of Commerce and Business Administration
University of British Columbia
***Journal of International Business Education*, 2003, in press.**
Revised May 11, 2003

INTRODUCTION

The recently completed World Summit on Sustainable Development in South Africa, convened to assess global progress since the landmark Rio conference of 1992 (UN, 1992), has reaffirmed the international commitment to the concept of sustainability. One result of this conference will be increasing pressure upon the business community to incorporate principles of sustainability into their business practices. Several critical questions face managers and owners unfamiliar with this potential new threat to business as usual: What is sustainable development? How should business respond? What kind of opportunities and threats lie in the new business environment, and how are such conditions related to sustainable development? Are the opportunities and threats related to each company's ability to achieve or move closer to sustainable development, or do opportunities and threats arise from implementing sustainable development practices? This paper attempts to answer these questions and provide an introductory guide to issues of sustainable development and associated analytical tools for business school students at both the senior and MBA levels.

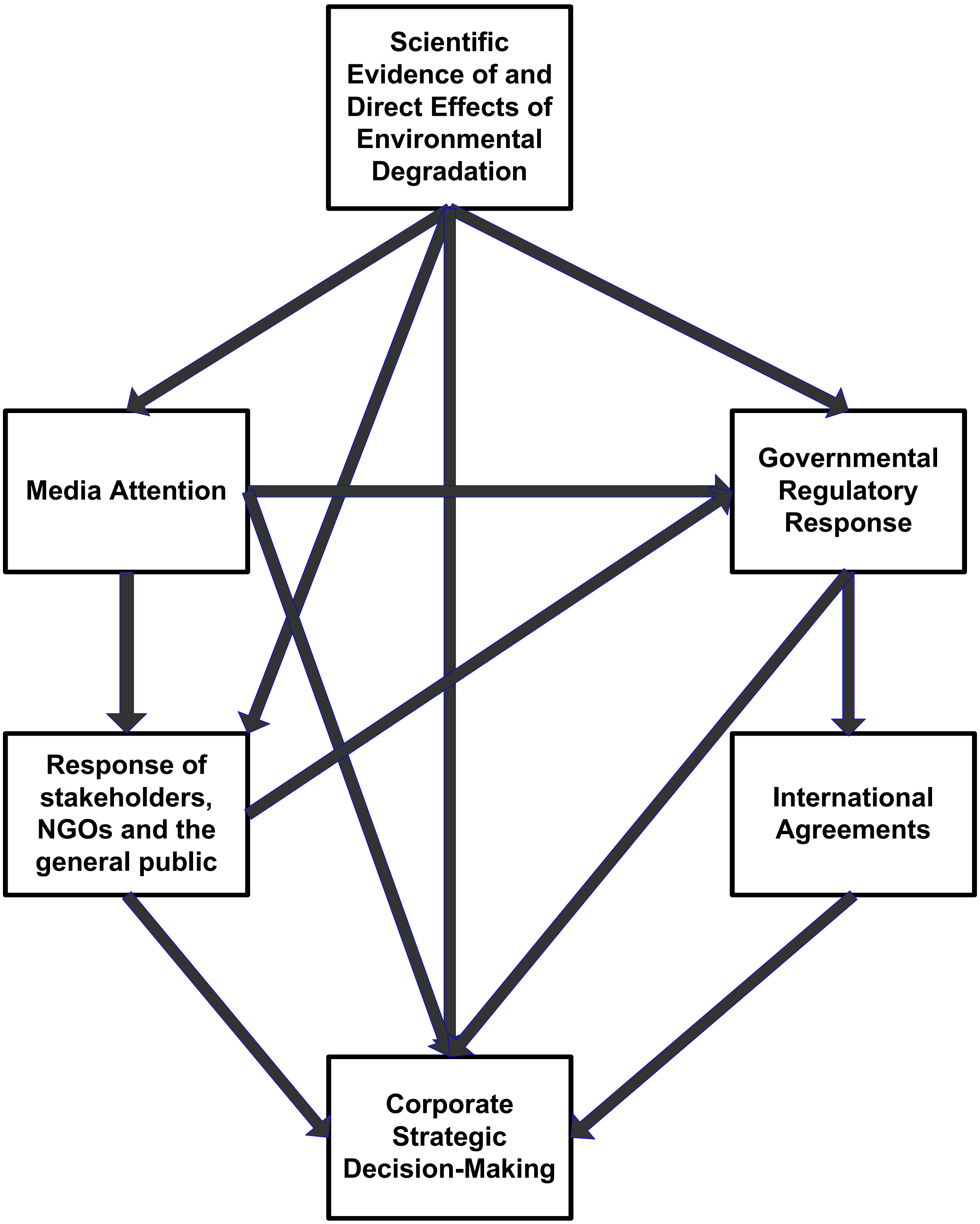
HISTORICAL BACKGROUND

Environmental issues have had an increasingly important impact on the conduct of business since the decade of the 1960s. The past four decades have been punctuated by high-visibility, environmentally-related disasters such as Seveso (1976), the Amoco Cadiz (1978), Three Mile Island (1979), Bhopal (1984), Chernobyl (1986), Exxon Valdez (1989), Indonesian forest fires (1997-2000), the sinking of the oil tanker, *Prestige*, off the western coast of Spain (2002), etc. Each such event and lesser, more local, instances of environmental degradation has raised public awareness and helped propel increasing governmental environmental regulation of business.

Fisher and Schot (1997) have tracked a progressive change in corporate responses to environmental issues over the last quarter century: the first period, from 1975-85 was characterized largely by corporate resistance to regulation and a begrudging acceptance of what were perceived as uniformly cost-increasing, regulatory requirements. Part of this attitude was conditioned by a relatively inflexible regulatory stance that focussed on command and control mechanisms which mandated pre-specified levels of end-of-pipe treatment of industrial emissions.

The authors have identified the period following 1985 as one of slowly emerging strategic responses to environmental issues based on the realization that such issues carry with them the opportunity for competitive advantage through an array of responses at every stage of the value chain. Underlying all these changes has been the emergence of a complex new network of forces which are directly and indirectly influencing corporate decsionmaking at all organizational levels. **Figure 1** presents a summary overview of these forces, most of which pose challenges to tradi-

FIGURE 1



Scientific Evidence of and Direct Effects of Environmental Degradation
Media Attention
Governmental Regulatory Response
Response of stakeholders, NGOs and the general public
International Agreements
Corporate Strategic Decision-Making

tional business practice. The factors driving corporate response to the environmental challenge are multifaceted, and include *inter alia* the direct impact of environmental degradation on corporate operations, media exposure, a vast array of changing stakeholder attitudes, and national and international regulatory requirements [See Annex A]. Governmental regulatory philosophy and practices have evolved significantly in this period as many jurisdictions have begun to adopt innovative, market-based instruments to facilitate the more efficient attainment of socially-mandated environmental goals.

Within the last decade, a new more powerful challenge to business has emerged, with the expansion of traditional concerns over pollution control to encompass ecological, social and economic issues under the general rubric of sustainable development. The successful response of the international business community to this new challenge can only be achieved if there is a clear understanding of the fundamental scientific, social, political and economic issues which underlie this concept. As such, this paper is divided into five parts: the first, briefly defines the concept of sustainable development and outlines some of the major scientific issues at play; the second describes the potential contribution of economics to this debate; the third discusses how issues of sustainable development are influencing government policies; the fourth describes the impact of this issue on business and how it can and does respond; and the final section speculates briefly about the future course of business in a planet under threat.

PART I: SUSTAINABLE DEVELOPMENT – SCIENTIFIC ASPECTS

The term "sustainable development" emerged from the World Commission on Environment and Development established by the United Nations in 1983. Known as the Bruntland Commission, after the chair Gro Harlem Bruntland, the Prime Minister of Norway, this conference was convened to discuss the critical issues of ecological degradation and Third World development. The definition of sustainable development which emerged from the Conference was beguilingly simple: development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 8).

The concept has proven to be much more intractable than first anticipated; one study by the World Bank (Pezzey, 1992) enumerated almost three dozen definitions of the term. In fact, on the face of it, the concept seems profoundly oxymoronic, as no process of continual *development* can be *sustained* in a closed system. Several attempts have been made to address this paradox: first, by focusing more on the *sustainability* of human activities rather than *sustainable development* per se; and second, by adopting a more narrow definition of development, focussing on the *quality* – as distinct from the *quantity* – of output; yet the fundamental challenge of how to both conceptualize the principle and implement it remains unresolved.

One of the most common interpretations of the concept is based on the analogy of a three-legged stool. Sustainable development requires the simultaneous achievement of sustainability in three disparate spheres: economic, ecological and social. In the last category, sustainable development must address both intragenerational and intergenerational equity; i.e. issues of empowerment and distributional equity not only among the current inhabitants of the earth, but also across generations yet to be born. Clearly, *empowerment* across generations is beyond realization, and intergenerational *equity* itself poses an extraordinary challenge given basic human values and time preference. It is an inherent human trait to value the present more than the future, if for no other reason than mortality. A system with even modest discount rates assigns any future costs and benefits (i.e. specifically those which affect future generations) past 50 or more years a minimal or essentially zero value. This problem affects the distribution of resource availability across generations and, *in extremis*, can lead through rational economic behaviour to the depletion or extinction of a renewable resource base required for continued human sustenance or survival.

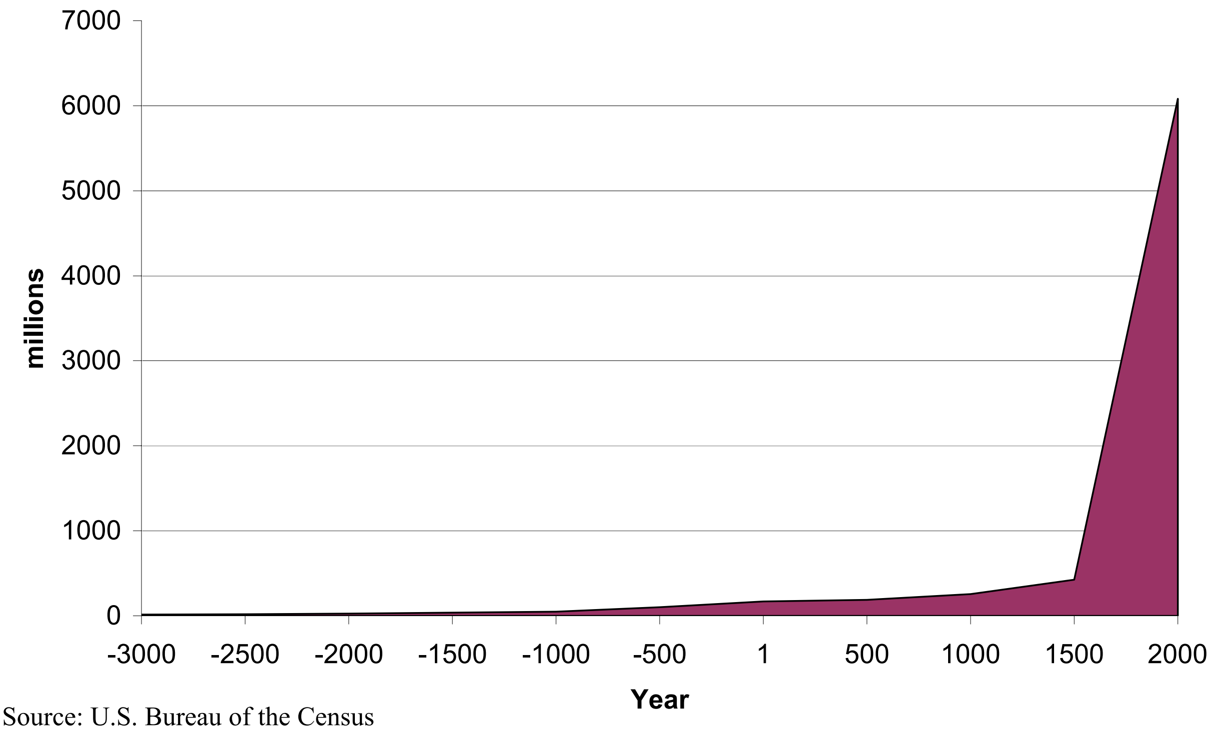
Several pieces of emerging evidence have led a majority of the scientific community to the conclusion that the human species and the planet we inhabit are facing unprecedented levels of ecological stress: (1) anthropogenic emissions of several climate-forcing and other pollutants (such as carbon dioxide, methane, sulphur dioxide and nitrogen oxides) equaling or exceeding natural emissions for the first time in human history; (2) damage to the stratospheric ozone layer and global warming, with accompanying climatic change; (3) loss of land borne and aquatic species and consequent decrease in planetary biodiversity; (4) the pervasive global presence in waterbodies, plants and animal tissue of heavy metals and chlorinated organic chemicals; (5) increasing pressure on global supplies of freshwater; (6) extensive soil degradation due to water and wind erosion, (7) continued degradation of global forests, a keystone species in most ecological systems; and (8) the spread of vector-borne diseases into geographic areas previously inhospitable to the establishment and transmission of such diseases (Settle and Patterson, 1980; AMAP, 1997; UNEP, 1999, 2002; IJC, 2000; McNeill, 2000; WRI et al., 2000; WWF et al., 2000; UNEP et al., 2001; WMO and UNEP, 2001; Barnes et al, 2002; Harvell et al., 2002; IOMC, 2002; Kolpin et al., 2002; Rosegrant et al., 2002; UNEP, 2002; Werth and Avissar, 2002).

With the exception of the first factor, the interpretation of none of these signs or symptoms is without contention. Until recently, for example, no scientific consensus had formed whether global climate change was indeed occurring and, if so, whether it was being significantly influenced by human activity. A major research study recently published by the U.S. National Academy of Sciences (NRC, 2001) represented a crucial advance in scientific thinking on this issue and stated conclusively that "Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. . . . Global warming could well have serious adverse societal and ecological impacts by the end of this century." (See also Justus and Fletcher, 2001).

Part of the problem of interpretation is that some symptoms of ecological distress have remained masked. A case in point is global fisheries where well-publicized declines in such important commercial catches as Atlantic cod (Speer et al., 1997) have appeared to have been offset by continued increases in total global fish harvests. Only recently, with advances in fisheries theory and empirical research, has it become apparent that the fundamental threat to sustainable fisheries has been hidden by the progressive depletion of species (Speer et al., 1997; see also Jackson et al., 2001; Dayton et al., 2002) and a process of "fishing down the food chain" where fish within successively lower trophic layers are targeted for harvest. This not only threatens the survival of species within each trophic level but also robs fish within higher trophic levels of the food necessary for stock rebuilding or survival (Pauly, 1999).

Why have we been only recently alerted to these major ecological threats? Because of the arithmetic of exponential growth, only now have human population growth and economic development reached a level which poses a threat to global ecological integrity. **Figures 2 and 3** track the path of both variables over history. These types of graphs are intimately familiar to ecologists who see in this history of human activity a species growing exponentially without constraints in a closed system. Few such examples exist in nature. Our ecological system, based on a highly complex web of interdependencies and controls, operates to limit the unconstrained growth of any species u **FIGURE 2**

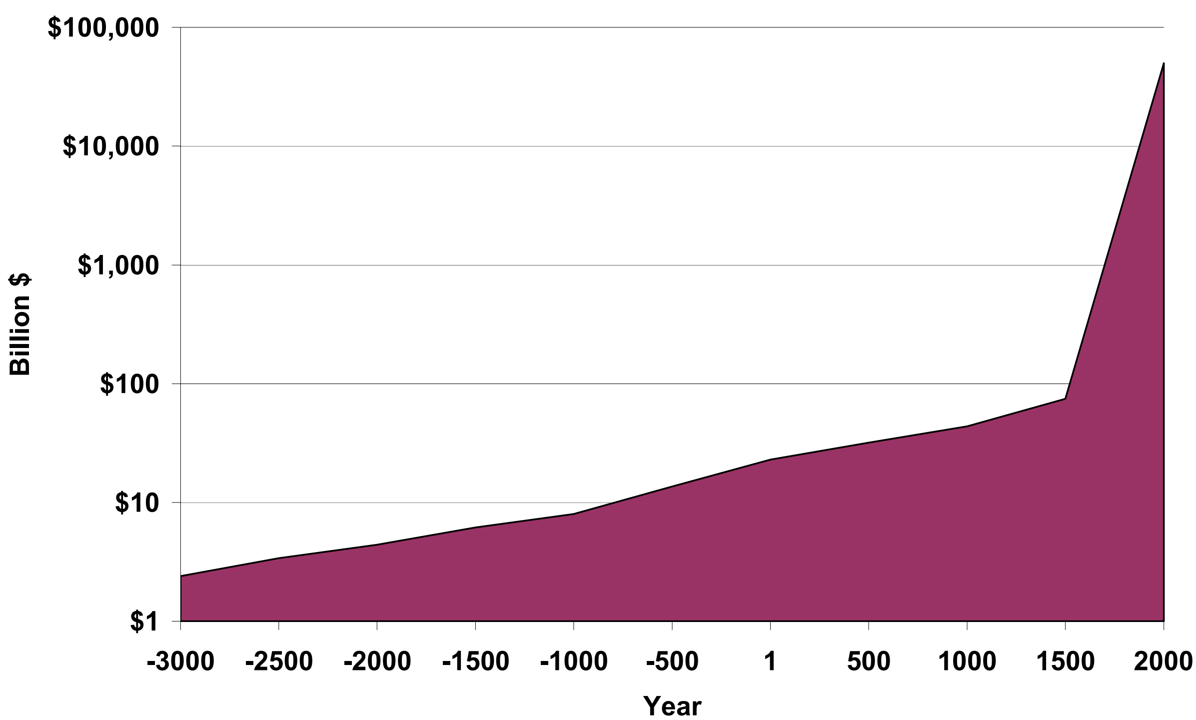
GLOBAL POPULATION



Source: U.S. Bureau of the Census

FIGURE 3

WORLD GDP



Source: Professor J. Bradford DeLong, Economics, Department, UC-Berkeley which can threaten the integrity of its immediate environment, the survival of other species, and even its very own continued existence. In those rare instances where such natural constraints have been removed – usually by the conscious or unconscious actions of mankind – the results are predictable: an initial exponential increase in population, followed inexorably by a population collapse. One sobering example of this type of phenomenon as it applies to human civilization has been demonstrated by recent research on the now disappeared population of Easter Island.

Case Study #1: Easter Island

When Dutch explorers first discovered Easter Island in 1722, they found only the squalid remains of a once thriving population reduced to warfare, cannibalism and barely subsistence level food production on an island stripped of its forest cover. Juxtaposed on the collapsed civilization were 600 massive stone statues towering as high as 65 feet and weighing up to 270 tons (Diamond, 1995). The population, which had peaked at approximately 7000 almost two centuries prior to their discovery, had built an advanced society sustained by the liquidation of the stock of forest capital which blanketed the island. The trees had provided essential material for fuel, construction of housing and boats, fishing nets and the transportation of the stone statues from inland quarries to the shore. The inevitable loss of forest cover led to a devastating array of ecological consequences, imprisoning the inhabitants on an island without houses, canoes, proper fishing nets or fertile soil. The population collapse was inevitable.

The unsettling lesson of Easter Island is that despite the fact that the islanders could observe the exhaustion of the forest resource which was essential for their survival, they were unable to devise a social-economic-political system that allowed them to find the right balance with their environment. One suggested explanation for this suicidal behaviour was the increasingly fierce competition for the remaining dwindling resources among rival groups on the island. This bears a disturbing resemblance to modern day national behaviour toward dwindling resources such as certain fish stocks (e.g., cod and whales). The dismal history of Easter Island provides a striking example of the dependence of human societies on their environment and of the consequences of irreversibly damaging that environment. Like Easter Island, the earth has only limited resources to support human society and all its demands. Like the islanders, the human population of the earth has no practical means of escape. The economist, Kenneth Boulding, coined the phrase "Spaceship Earth" in an attempt to capture the essence of this dilemma faced by mankind. (See also: Ponting, 1991; Brander and Taylor, 1998) In fact, Easter Island is but one example of numerous civilizations throughout history which have "committed ecological suicide by destroying their own resource base" (Diamond, 1999, p. 411).

In essence, Easter Island represents a worst case scenario of global futures. Without a concerted and coordinated international response, the current growth of human population and industrial output pose the ultimate challenge – to find some level of sustainable interaction between humankind and the ecological system before natural control mechanisms such as disease and famine lead inevitably to the "Easter Island effect" – the collapse of the environment which sustains current levels of human activity.

It is interesting to observe that as a shift in scientific thinking has taken place, a similar change in worldview has occurred in at least one sector of the business world. One of the most conservative sectors of the business community has already concluded that global warming is indeed taking place and is actively campaigning for a concerted corporate and governmental response. The insurance industry has published data (www.munichre.com.) to support their contention that the increasing number and severity of certain types of natural disasters, such as floods, storms and tornadoes, is linked to human-driven climate change. (For more recent evidence, see Goldenberg et al., 2001; Wigley and Raper, 2001; U.S. PIRG, 2001).

One important signal in assessing the current status of sustainability can be derived from environmental trends at the national level. Here, the evidence is mixed at best. One keystone gauge of the success or lack thereof in achieving sustainability is national levels of greenhouse gas (GHG) emissions. The 1997 Kyoto Protocol, reaffirmed in July 2001 by 178 nations (*New York Times*, July 24, 2001) and again in Johannesburg in September 2002, adopted as a central goal the reduction of GHG emissions from the 38 industrialized countries[1] "by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012" (UN, 1998). The most recent data suggest that GHG emissions in most developed countries are in fact on the increase. **Tables 1-4** illustrate the large international variance in the levels and growth of carbon dioxide emissions (US EIA, 2001b). **Figure 4** summarizes historical CO_2 emission data for the United States, the world's largest producer (US EIA, 2001; ORNL, 2001). The trends in these data are not surprising considering the increasing use of energy – most notably fossil fuels — and the intimate connection between energy consumption and carbon dioxide production.

In order to move closer to a path of sustainability, it is essential to delink energy consumption and CO_2 production from Gross Domestic Product (GDP). It was conventional wisdom prior to the oil crises of 1973 and 1979 that the delinkage of energy consumption and GDP was not possible. It has now become apparent that some countries have achieved such a delinkage with respect to energy and CO_2 emissions. If such a delinkage were broadly possible, it could bring sustainable development one step closer to realization. Under these circumstances, Third World countries, striving to increase their standard of living, could increase their use of energy without a comparable contribution to climate change.

Figure 5 compares the economic performance of several major countries with changes in their GHG emissions over the last decade. Those countries below the diagonal line in Quadrant I (the upper right) have managed to keep their growth in GHG emissions below their annual growth rate of GDP. The best performance is manifested by those nations in Quadrant IV (the lower right) which appear to have achieved some degree of delinkage (Germany, the UK and France). Germany may represent a special case, however, since its reductions in CO_2 emissions over the last decade, despite continuing economic growth, are partially related to the retirement and replacement of older, more pollutant-intensive equipment in the former East Germany. Interestingly, the three countries whose rate of increase in GHG surpassed that of GDP over the period 1990-98 (China, Denmark and the Netherlands) have managed to achieve reductions in GHG over the period 1998 to 2000 (US EPA, 2001; NRDC, 2001). China may also be a special case, as it has been undergoing a process of industrial restructuring, part of which entails the shifting of its energy base away from its extensive reliance on coal. Its rapid industrialization has entailed significant increases in the use of more efficient production technologies. Such results are encouraging, but China's rapid growth from a relatively small and inefficient industrial base is not typical of most developed economies. Part of the reason for the delinkage of CO_2 emissions and GDP in Germany and other European countries such as Denmark, The Netherlands and the United Kingdom may be the adoption of innovative ecological tax reform. (See Part III).

Several critical factors temper the optimistic conclusions that might be drawn from such recent successful examples of policy innovation and industrial restructuring which are consistent

Table 1: Total CO2 Emissions (as C), 1999 - Selected Countries

Country	Million MT	%	Country	Million MT	%
World Total	**6,143.62**	**100%**	Brazil	88.90	1%
USA	1,519.89	25%	Poland	84.54	1%
China	668.73	11%	Iran	84.32	1%
Russia	400.09	7%	Spain	81.55	1%
Japan	306.65	5%	Saudi Arabia	73.93	1%
India	243.28	4%	Netherlands	64.35	1%
Germany	229.93	4%	Indonesia	64.34	1%
Ukraine	152.39	2%	Taiwan	63.01	1%
Canada	150.90	2%	Turkey	49.96	1%
Italy	121.28	2%	Thailand	44.57	1%
France	108.59	2%	Argentina	39.49	1%
Korea, South	107.49	2%	Venezuela	37.94	1%
Ukraine	104.30	2%	Belgium	37.90	1%
Mexico	100.56	2%	Egypt	33.49	1%
South Africa	99.45	2%	Korea, North	33.43	1%
Australia	93.90	2%	UAE	32.19	1%

Source: US EPA Website

Table 2: Growth of CO2 Emissions (as C), 1990-99 - Selected Countries

Country	% change	Country	% change
World Total	5%		
Taiwan	97%	Japan	14%
Korea, South	77%	New Zealand	13%
Singapore	58%	United States	12%
India	56%	Netherlands	12%
Indonesia	55%	China	8%
Brazil	42%	Italy	8%
Argentina	39%	Sweden	7%
Spain	32%	France	6%
Australia	30%	Nigeria	6%
Norway	27%	Switzerland	0%
Saudi Arabia	26%	United Kingdom	-7%
Mexico	20%	Germany (1991-99)	-8%
Canada	18%	Finland	-10%
Austria	15%	Russia (1992-99)	-30%

Source: US EPA Website

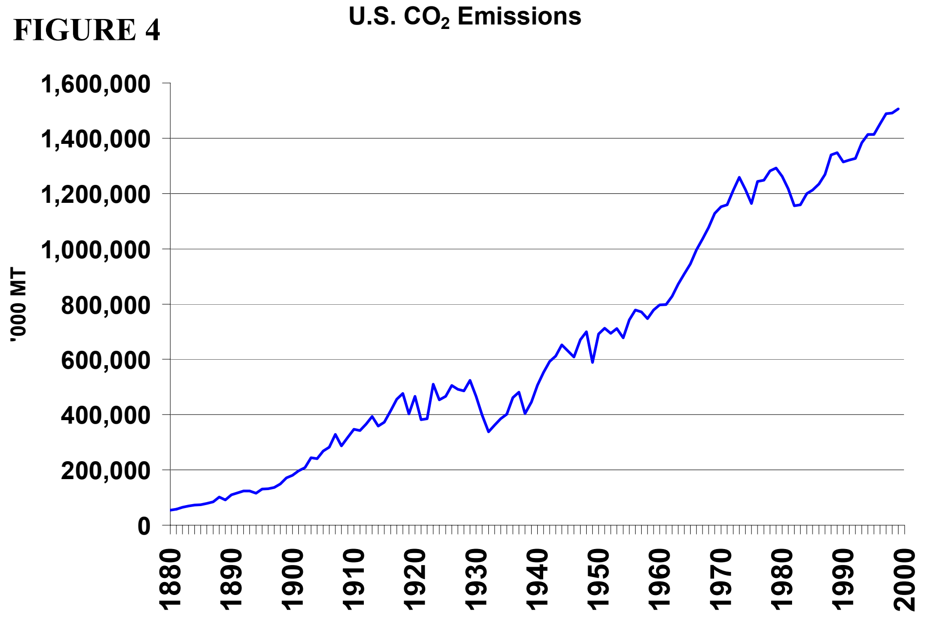
Table 3: Per Capita CO2 Emissions (as C), 1999 - Selected Countries

Country	MT/cap		MT/cap
Qatar	14.2	**World Total**	1.0
Singapore	6.4		
United States	5.6	**North America**	4.4
Australia	5.0	**Western Europe**	2.1
Canada	4.9	**E. Europe & Former U.S.S.R.**	2.0
Germany	2.8	**Middle East**	1.8
Russia	2.7	**Central and S. America**	0.6
United Kingdom	2.6	**Far East and Oceania**	0.5
Japan	2.4	**Africa**	0.3
France	1.8		
Sweden	1.8		
Switzerland	1.7		
Brazil	0.5		
China	0.5		
Indonesia	0.3		
India	0.2		
Pakistan	0.2		
Bangladesh	0.1		
Sierra Leone	0.1		

Table 4: CO2 Emissions (as C) per '000 Dollars of GDP, 1999 Selected Countries

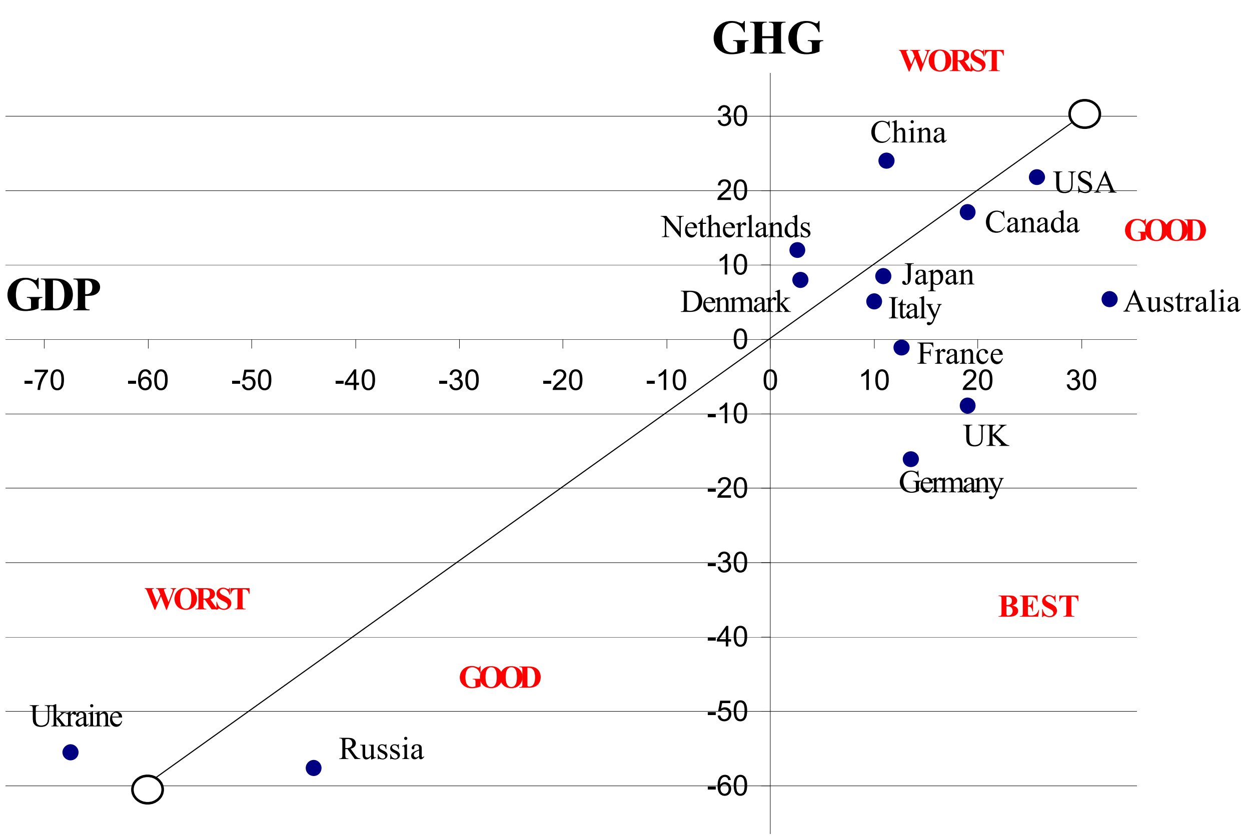
Country	MT/000$	Country	MT/000$
Azerbaijan	2.46	Canada	0.21
Russia	1.11	United States	0.20
Qatar	1.02	Brazil	0.15
China	0.72	United Kingdom	0.13
India	0.51	Germany	0.12
Pakistan	0.48	Japan	0.09
Indonesia	0.40	France	0.08
Singapore	0.36	Sweden	0.06
Australia	0.22	Switzerland	0.05
Bangladesh	0.22	Burkina Faso	0.03

FIGURE 4



Source: U.S. EPA

FIGURE 5: A GHG NATIONAL SCORECARD



% Changes in GHG emissions and real GDP 1990-98

Source: U.S. EPA, IMF, World Bank

with movement toward sustainability goals. The first is contained in a report from the U.S. Energy Information Administration (2001a) which forecasts continued increases in energy consumption and CO_2 generation until 2020 [see **Table 5**].

The second is the increasing attraction of the automobile to newly industrializing countries. **Tables 6 and 7** shows the extent of automobile ownership among several countries and recent growth in car registrations (Ward's, 2000, 2001a,b). Since the transportation sector is one of the principal users of material and energy resources and generators of greenhouse gases, this shift in consumer taste and buying power will tend to be retrogressive in the quest for sustainability.

The third is the increasing pressure on agricultural lands to feed a population growing in numbers and affluence. Recent research suggests that this pressure will have major negative feed-back effects on ecological systems and ultimately food production (Tilman, 2001).

The fourth issue which counsels caution in the interpretation of potential movement toward a more sustainable industrial system arises from recent pathbreaking research by the World Re-

Table 5: Projections of Global Energy Consumption and Carbon Dioxide Emissions

Energy Consumption in Quadrillion Btu

REGION		1990	1999	2010	2020
Industrialized		**182.4**	**209.6**	**243.4**	**270.4**
EE/FSU		**76.3**	**50.5**	**60.3**	**72.3**
Developing					
	Asia	51.0	70.9	113.4	162.2
	Middle East	13.1	19.3	26.9	37.2
	Africa	9.3	11.8	16.1	20.8
	Central & S. America	13.7	19.8	29.6	44.1
	Subtotal	**87.2**	**121.8**	**186.1**	**264.4**
World		**346.0**	**381.8**	**489.7**	**607.1**

Carbon Dioxide Emissions in Million Metric Tons of Carbon Equivalent

REGION		1990	1999	2010	2020
Industrialized		**2,842**	**3,122**	**3,619**	**4,043**
EE/FSU		**1,337**	**810**	**940**	**1,094**
Developing					
	Asia	1,053	1,361	2,137	3,013
	Middle East	231	330	451	627
	Africa	179	218	294	373
	Central & S. America	178	249	394	611
	Subtotal	**1,641**	**2,158**	**3,276**	**4,624**
World		**5,821**	**6,091**	**7,835**	**9,762**

Source: U.S. EIA

TABLE 6: MOTOR VEHICLE REGISTRATIONS - 1999

REGION	Passenger	Commercial	Total	Population (millions)	Pop/Car
Western Europe	182,397,776	25,456,628	207,854,404	390.2	2.1
Pacific	11,964,775	2,972,163	14,936,938	29.2	2.4
North America	146,011,461	92,609,997	238,621,458	405.3	2.8
Eastern Europe	21,259,292	3,556,078	24,815,370	155.6	7.3
Central & S. America	25,865,275	8,537,709	34,402,984	375.8	14.5
Middle East	13,047,916	5,855,555	18,903,471	290.0	22.2
Caribbean	1,560,800	522,795	2,083,595	36.0	23.1
Far East	81,385,752	45,534,024	126,919,776	3,251.8	40.0
Africa	8,104,743	5,156,072	13,260,815	660.6	81.5
WORLD	**491,597,790**	**190,201,021**	**681,798,811**	**5,594.6**	**11.4**

Source: Wards, 2000, 2001

TABLE 7: GROWTH IN PASSENGER CAR REGISTRATIONS 1997-98

COUNTRY	1997	1998	Population ('000)	% increase 97-98
WORLD	**452,101,260**	**477,095,800**	**5,913,286**	5.53
Indonesia	409,800	491,457	209,255	19.93
Iran	572,925	684,500	66,796	19.47
China	2,493,700	2,940,243	1,266,838	17.91
Korea, South	6,694,100	7,850,926	46,480	17.28
Brazil	9,385,800	10,828,765	167,988	15.37
Thailand	1,509,900	1,712,900	60,856	13.44
Malaysia	2,102,400	2,373,200	21,830	12.88
Philippines	671,007	749,204	74,454	11.65
Argentina	3,137,500	3,468,082	36,577	10.54
Japan	45,861,700	50,353,749	126,505	9.79
India	4,446,500	4,820,000	998,056	8.40
Taiwan	4,201,000	4,536,605	22,113	7.99
Australia	7,785,800	8,400,102	18,705	7.89
United States	125,965,709	131,838,538	276,218	4.66
Canada	13,300,000	13,887,270	30,857	4.42
United Kingdom	21,881,000	22,115,000	58,744	1.07
Germany	41,371,992	41,673,781	82,178	0.73

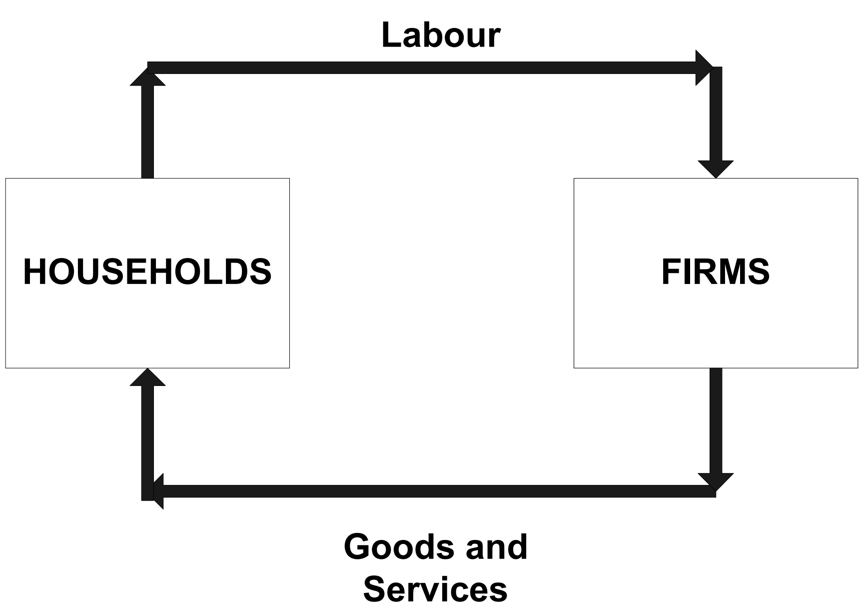
sources Institute on material outflows from industrial economies (Matthews et al., 2000). In this report which focuses on five industrialized countries (Austria, Germany, Japan, The Netherlands and the U.S.), the authors conclude that while significant progress has been made in "decoupling between economic growth and resource throughput . . . on a per capita and per unit GDP basis, . . . overall resource use and waste flows into the environment continued to grow."

PART II: SUSTAINABLE DEVELOPMENT – ECONOMIC ISSUES

Much of our foundational economic theory which models human productive activity developed in an era when humanity's impact on the natural environment was orders of magnitude less than it is today. The neo-classical model of economics has a powerful mechanism in the price system to make adjustments for resources that become scarce. As commodity or service scarcity increases, commensurate price increases tend to ration the use of this good or service and create an incentive for technological innovation and product substitution. This highly efficient mechanism works only when the good or service in question falls within the purview of the market system. In the traditional neo-classical model the exchange between households (as generators of labour and consumers of goods and services) and producers (as purchasers of labour and purveyors of products) [see **Figure 6**] had no need, however, to include resources such as clean air, water or assimilative capacity because they were free and perceived to be unlimited.

It was only after the publication of Rachel Carson's seminal work *Silent Spring* in 1962 that the general public was first awakened to the magnitude of the potential problem of environmental degradation. To its credit, the economics profession in relatively short order proceeded to develop the new subdiscipline of environmental economics. Fundamental to this disciplinary theory is the principle that scarce resources such as environmental amenities will be overused and degraded as long as they remain outside the market system; i.e. if they are unpriced. In the language of the discipline, *externalities* have to be *internalized* and property rights assigned to common property resources in order to correct the "market failure" which can threaten the continued production of

FIGURE 6



goods and services. [Many of the seminal articles in this field have been reproduced in Dorfman and Dorfman, 1993 and Stavins, 2000].

At one level, the normative principles of this new discipline have induced a notable transformation in government policy and corporate and individual response. New market-based initiatives, such as emission taxes and tradeable emission permits, have replaced many of the old economically inefficient and frequently ineffective regulatory mechanisms for the reduction of pollution. Yet two fundamental problems remain: first, the issue of scale; and, second, the pricing of ecological services.

Firstly, with respect to scale, Herman Daly (1999) has observed that while optimality is the essence of microeconomics, there is no comparable concept of optimal scale in macroeconomics. To quote:

> The notion that the macroeconomy could become too large relative to the ecosystem is simply absent from macroeconomic theory. The macroeconomy is supposed to grow for ever. Since GNP adds costs and benefits together instead of comparing them at the margin, we have no macro-level accounting by which an optimal scale could be identified. Beyond a certain scale growth begins to destroy more values than it creates - economic growth gives way to an era of anti-economic growth. But GNP keeps rising, giving us no clue as to whether we have passed that critical point!

Secondly, while many externalities can be priced and consequently reduced or eliminated, there is no effective way to price the planet-level ecological services required for species survival. One of the most interesting research efforts to address this problem was published in *Nature*, one of the world's most respected scientific journals (Costanza et al., 1997a). Thirteen prominent economists and ecologists collaborated in an attempt to establish a monetary value for the world's ecosystem services and natural capital. To quote:

> The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16-54 trillion per year, with an average of US$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.

Table 8 enumerates the components of ecosystem value derived from this research exercise. (See also Daily, 1997). On reflection, the concept of deriving an economic value for ecosystem services seems patently absurd – for without these services, no one species, including humankind, could survive on this planet. In this respect, the value of such services is certainly infinite. Yet there is an innate human response to ignore values that are beyond the level of easy comprehension. This, then, is the real function of the analysis – to convince business people, policymakers and the lay public of the size of the problem in economic terms which can be more readily understood

TABLE 8: ESTIMATED TOTAL VALUE OF GLOBAL ECOSYSTEM SERVICES

Ecosystem Service	**Estimated Value (billion $)**
Nutrient cycling	$17,075
Cultural	$3,015
Waste treatment	$2,277
Disturbance regulation	$1,779
Water supply	$1,692
Food production	$1,386
Gas regulation	$1,341
Water regulation	$1,115
Recreation	$815
Raw materials	$721
Climate regulation	$684
Erosion control	$576
Biological control	$417
Habitat/refugia	$124
Pollination	$117
Genetic resources	$79
Soil formation	$53
TOTAL	**$33,266**

Source: Costanza et al., 1997

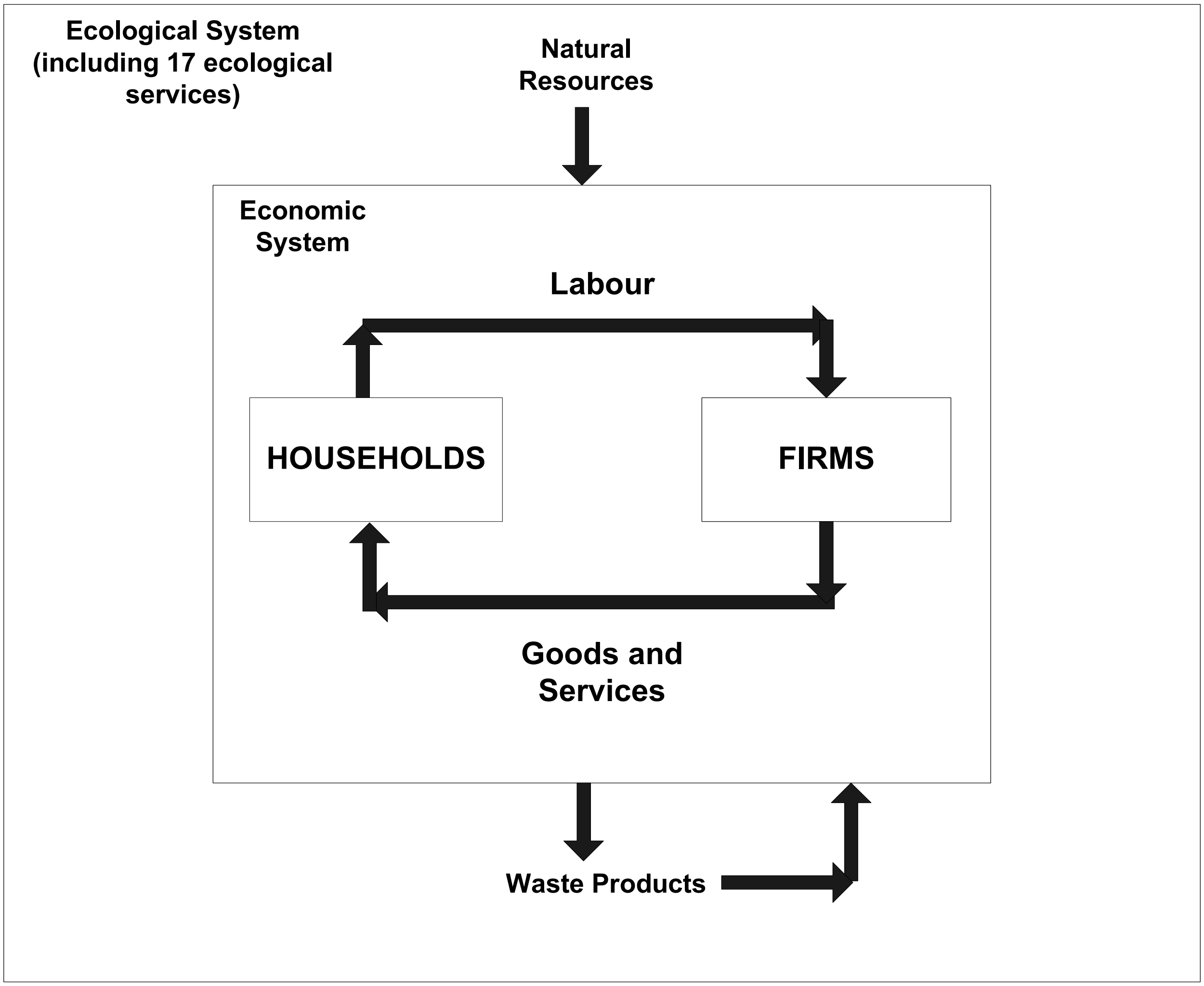
and interpreted. As such, the precision of the estimate is immaterial; it is the magnitude of the dollar value which is the ultimate value of this exercise.

If there is one major flaw of environmental economics, it is its failure to come to grips with the complex interaction of economic and ecological systems. To address this issue, a new discipline has emerged which attempts to fuse these two paradigms. Called ecological economics (Costanza, 1991; Jansson et al., 1994; Costanza et al., 1997b), this discipline rests on a simple philosophical premise: that the economic system is embedded in the ecological system, cannot function without it, and is ultimately subject to the same laws and constraints which apply to natural systems.

Figure 7 presents a simplified representation of an integrated economic-ecological model. One of the most important components of this model is the feedback loop on anthropogenic waste products. Pollution generated by production processes and released into the environment has a negative impact on the economic system either indirectly by compromising one or more ecological services, or directly by threatening production processes or the humans which operate them. According to Costanza et al. (2002), pioneers in the development of this new paradigm:

> The core problem addressed in ecological economics is the sustainability of interactions between economic and ecological systems. Ecological economics addresses the relationships between ecosystems and economic systems in the broadest sense. It involves issues that are fundamentally cross-scale, transcultural and transdisciplinary, and calls for innovative approaches to research, to policy and to the build-

FIGURE 7



ing of social institutions. In this sense, ecological economics tends to be characterized by a holistic "systems" approach that goes beyond the normal territorial boundaries of the academic disciplines.

In addition to the concept of systems theory, several other conceptual threads run throughout studies of sustainability:
(1) a critical distinction between qualitative and quantitative changes in the utilization of our technology and natural resource base (i.e. *development* versus *growth*). Central to operationalizing this distinction are technological advances which may permit us to raise our standard of living without increasing the throughput of resources – a process commonly referred to as "dematerialization;
(2) a focus on social justice, stability and empowerment with particular emphasis on reducing poverty and maintaining an adequate quality of life for all global inhabitants;
(3) borrowing from principles of business sector accounting, a direct or indirect articulation of the concept of *natural* capital — where maintenance of a constant natural capital stock (including the renewable resource base and the environment) yields an indefinite stream of output or "income."

One central concept is the proposition that the current generation must leave the next generation a stock of capital no less than is currently available. Implicit in this proposition is that we must, to the best of our ability, live off the "interest" on this capital stock and not draw it down. If part of this capital is consumed, it must be replaced by substitute capital. The ability to achieve this goal hinges on which of two major definitions of "sustainable development" is adopted: "weak" sustainability or "strong" sustainability.

Under the weak sustainability constant capital rule, we can consume some of our natural capital (in the form of environmental degradation, for example) as long as we offset this loss by increasing our stock of man-made capital. In contrast, under the strong sustainability constant capital rule, there is no perfect substitution among different forms of capital. Some elements of the natural capital stock (such as life-support services) cannot be replaced by man-made capital. To implement either of these concepts requires the ability to distinguish more accurately among the various forms of capital (natural, human, physical). Without more accurate measures of these forms of capital, we cannot make the right decisions;

(4) a concept known as the "precautionary principle" (Harermoes et al., 2002) which states that one cannot wait for definitive scientific proof of a potential threat to the global ecosystem before acting, if that threat is both large and credible. The underlying theory is based on scientific principles, largely associated with the work of ecologists such as C.S. Holling (1973), that ecosystems under stress do not necessarily adjust slowly and steadily, but may jump suddenly between alternative equilibrium states, some much less hospitable for human activity than others. The import of this theory is that by the time one recognizes or begins to feel the tangible effects of certain types of ecological threats, it may be too late to act.

We are already amassing a significant body of scientific evidence to suggest what future global warming may entail – potentially profound changes in weather and climate, including a greater number and severity of super storms which concomitant economic damage and loss of life, increasing incidence and severity of droughts, a greater incidence of vector-based epidemics (for example, see Epstein et al., 1998), damage to forests and fisheries, and sea-level rises which will threaten heavily-populated low-lying areas throughout the world (IPCC, 1996). Among these negative effects, two of the most daunting are the potential for significant losses to productive farmland and food production (Fischer et al., 2001) and positive feedback loops which can lead to sudden global ecological changes.

Wallace Broecker (1987) has identified one significant historical example of this latter phenomenon. Northern Europe's climate is warmed by a salt water "conveyor" which flows from the South Atlantic. Scientific evidence has suggested that at several times in global history this conveyor has abruptly halted, leading to a lowering of average temperatures in Northern Europe of approximately 6 degrees Celsius. This temperature reduction is sufficiently large to imperil most of current European agricultural production. According to Broecker, changes in the conveyor system appear to be correlated with changes in levels of atmospheric carbon dioxide. To quote:

> The inhabitants of planet earth are quietly conducting a gigantic environmental experiment. So vast and so sweeping will be the consequences that, were it brought before any responsible council for approval, it would be firmly rejected. . . . My suspicion is that we have been lulled into complacency by model simulations that suggest a gradual warming over a period of about 100 years. . . . Earth's climate does not respond to forcing in a smooth and gradual way. Rather, it responds in

> sharp jumps which involve large-scale reorganization of Earth's system. . . . We must consider the possibility that the main responses of the system to our provocation of the atmosphere will come in jumps whose timing and magnitude are unpredictable.

The conveyor system identified by Broecker is but one example of a broader threat of abrupt changes associated with climate change recently enunciated by the U.S. National Academy of Sciences (NRC-NAS, 2002). With all these potential negative consequences of global climate change, the wisdom of considering the application of the precautionary principle becomes apparent. **Figure 8** presents a simplified conceptualization of this principle which can be applied to issues such as global warming.

As stated by Costanza, one of the most critical concepts brought by ecology to the study of human activity is that of systems or holistic analysis; i.e. the effect of any action or activity cannot be viewed in isolation, but must be viewed as part of an entire system. This theory is not new to the field of economics, as general equilibrium analysis and such applications as input-output analysis incorporate the essence of this concept. Several brief examples drawn from the transportation sector illustrate how this type of systems approach can inform public and private decision making in a manner which can advance the cause of sustainable development.

Case Study #2: Is Gasohol Sustainable?

The current American administration – like its predecessor — has renewed the government's commitment to the production and use of gasohol – a blend of 10% grain-based ethanol and 90% gasoline. The principal component of government support for ethanol production is a significant tax break which makes gasohol price-competitive with regular gasoline at the pump. Several

FIGURE 8 THE PRECAUTIONARY PRINCIPLE AND GLOBAL WARMING

	Global warming is occurring	Global warming is NOT occurring
We assume global warming is occurring and act on it	we can slow or possibly reverse the damage	we will make generally suboptimal investments (i.e. opportunity costs greater than the benefits)
We assume global warming is occurring and do nothing	we face disaster	we have nothing to worry about

major reasons have been advanced for this de facto subsidy: (1) to reduce dependence on foreign oil supplies, (2) to reduce urban air pollution, and (3) to provide additional income to the farm sector.

To appreciate why none of these reasons is correct, one must understand the technology of ethanol production. First, grain, corn or other biomass is converted to fermentable sugar. Next, these sugars are then fermented, typically with yeast, until they reach a natural limit of 12% ethanol. Finally, the alcohol content is increased to as high as 100% through the process of distillation. The critical factor in the entire process is the quantity of energy required for distillation. When net energy analysis (IES, 1975; Winstanley et al., 1977; Gilliland, 1978) is applied to the typical American ethanol process based on corn input and fossil fuel based distillation, it becomes apparent that ethanol production has near zero or negative net energy balance (Chambers et al, 1979; Hopkinson and Day, 1980; USDA, 1988). In common parlance, this means that it takes more energy to produce this fuel than is available from the final product in the form of useful energy. Net energy confirms the suspicion that if the government was not heavily subsidizing gasohol, no one would produce or consume it.

Why does a government ostensibly committed to free market principles continue to pursue a policy which appears irrational? Consider the three rationales for gasohol production. (1) *It reduces dependence on foreign oil*. Ironically, because of a potentially negative energy balance, the production of gasohol may marginally increase energy import dependence. (2) *It reduces urban air pollution*. The combustion of gasohol tends to decrease the emissions of carbon monoxide, but increase the output of hydrocarbons and production of ozone (NRC, 1999). It does, however, shift the locus of some pollution from the urban area to the areas where ethanol is produced. (3) *It produces additional farm income*. There may be a marginal increase in aggregate farm income, but there are farmers who lose as well as gain from this policy (USDA, 1988).

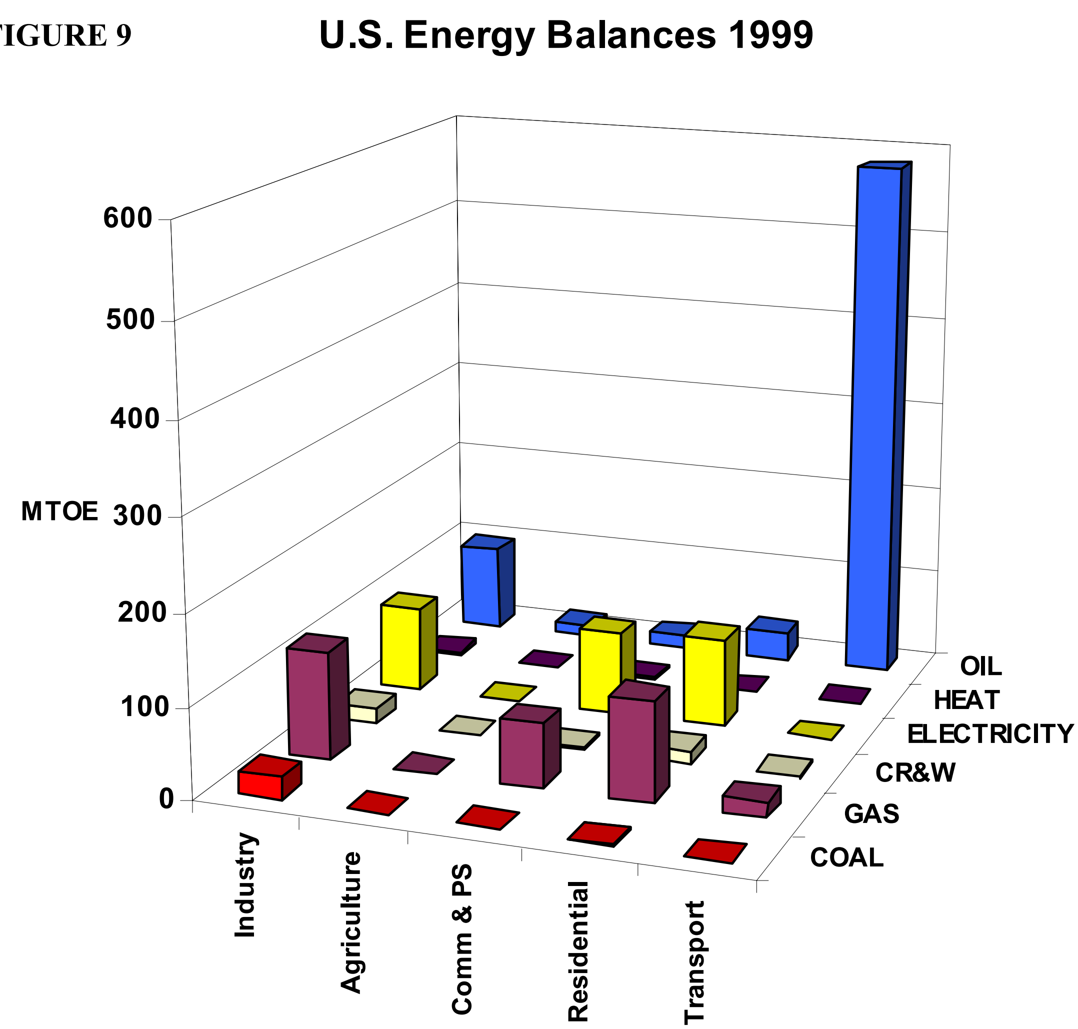
Several hypotheses have been advanced for government maintaining policies which are favourable to the production of gasohol. First, government may wish to appear to be tackling the problem of foreign oil dependence which now exceeds 50% of domestic consumption – a figure above that which characterized the energy crises of the 1970s. Second, the government may wish to appear to be addressing the problem of urban air pollution, although there are other more cost-effective ways of doing so, such as tighter fuel economy and emission standards and higher gasoline taxes. Or, finally, the government may be responding to special interest group lobbying. Promoting the use of gasohol increases the income of farmers who produce the feedstock for ethanol. In addition, there has been a strong lobbying effort for many years by the agrobusiness giant, Archer Daniels Midland (ADM), which is estimated to control between 60 and 75 percent of U.S. ethanol production. ADM has made significant financial contributions to both Democratic and Republican parties over the last decade (Bovard, 1995; *New York Times*, January 16, 1996). James Bovard, an analyst with the CATO Institute, an American conservative think tank, has commented that "A.D.M.'s political strategy has long been based on the ideas that politicians should control prices and markets, and that A.D.M. and Andreas [the company's CEO] should control politicians" (*New York Times*, January 16, 1996).

Regardless of which positive explanation for government intervention is correct, the continued production and use of ethanol in the transportation sector, with current technology, agricultural practices and feedstock, contributes nothing to sustainability and distracts government from more productive, but potentially less politically palatable, policies to create a more sustainable transportation sector.

Case Study #3: Is The Automobile Sustainable?

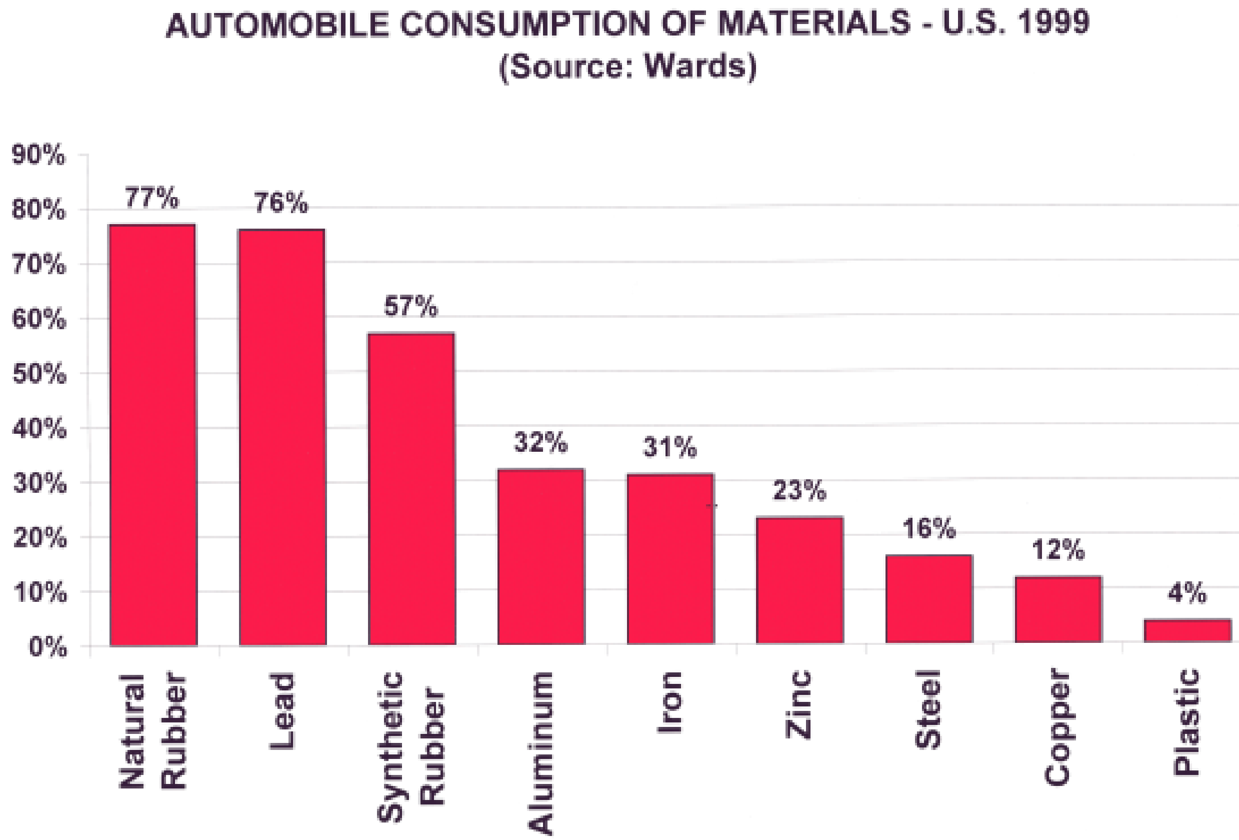
The invention of the automobile has had an extraordinary impact on the development of our modern economy and society. The motor vehicle has had a profound influence on the size and configuration of our cities and how we conduct our everyday lives (Freund and Martin, 1993). Despite these manifest benefits, it can be argued that the automobile is one of the largest generators of negative externalities in the world. Its effects include: (1) the emergence of vast, spread out cities with concomitant high energy costs and massive infrastructural requirements; (2) traffic congestion; (3) noise pollution; (4) injuries and fatalities. For example, in the U.S. in 1999 there were 6.3 million traffic accidents, resulting in 3.2 million injuries and 41,611 deaths (Wards, 2001a); (5) the largest single user of energy and material in our modern industrial society (see **Figures 9 and 10**); and (6) the creation of one of the most important contributors to environmental degradation. (See **Figure 11 and Table 9**).

FIGURE 9



Source: OECD, 2001c

FIGURE 10



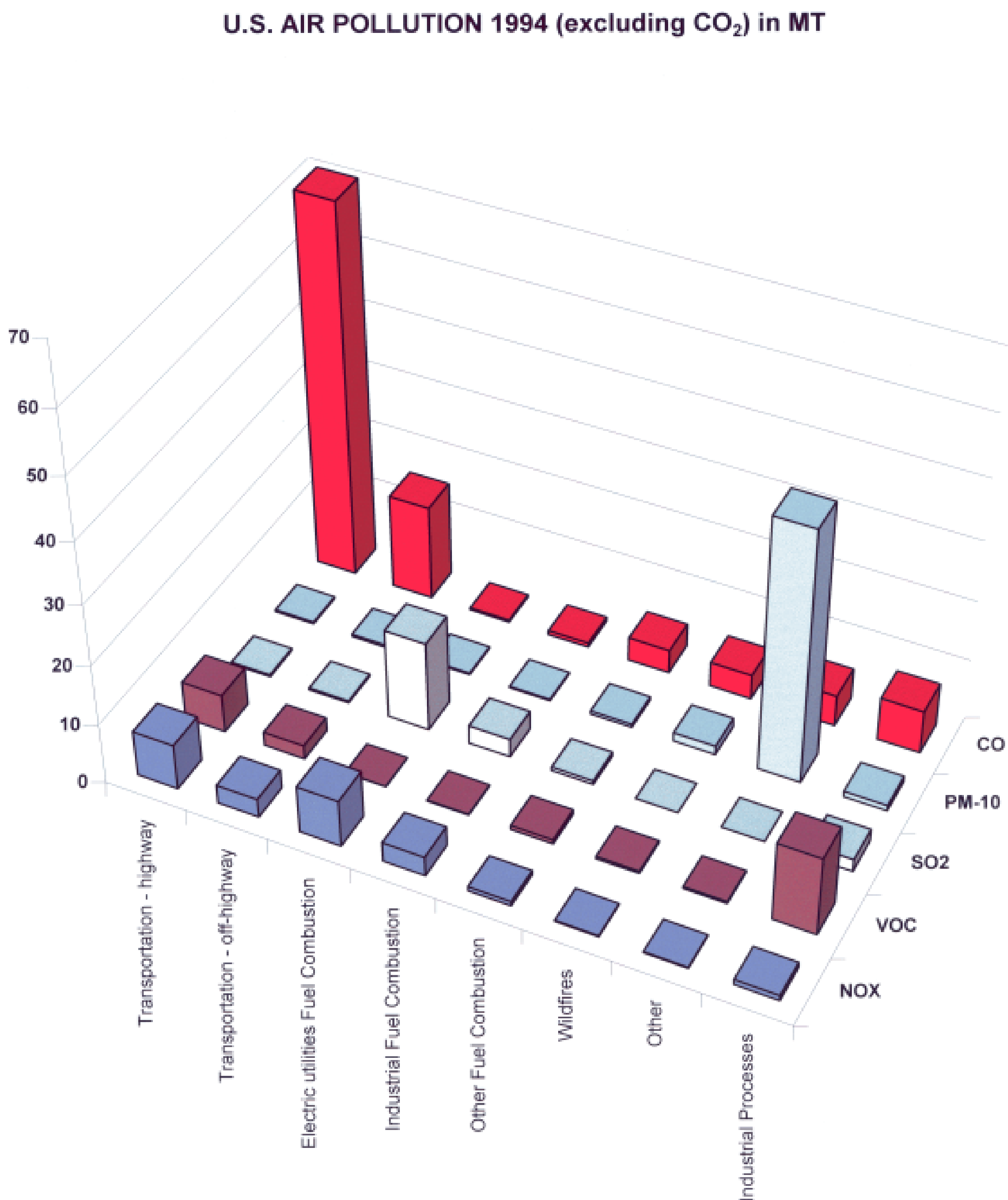
Several recent studies have provided estimates of the social cost of driving – all considerably in excess of the private costs (see, for example, MacKenzie et al., 1992; Miller and Moffet, 1993; ICTA, 2000; EEA, 2001; TTI, 2002). As much as we love our automobiles, we should not delude ourselves into thinking that their continued utilization represents any contribution to sustainable development.

The accumulating mass of scientific evidence of threats to the global environment, mediated by public and media attention, has motivated both the governmental and corporate sectors to address the emergent issue of sustainable development. The operationalization of sustainable development requires both new ways of conceptualizing the interrelationship between human activity and the environment, and tools for incorporating these concepts into everyday public and private sector decision making. The section which follows outlines some of the creative solutions already adopted by governments, most particularly in Europe.

PART III: OPERATIONALIZING SUSTAINABLE DEVELOPMENT – PUBLIC SECTOR TOOLS

The conventional methodology for evaluating major public sector decisions has been cost-benefit analysis, expanded more recently to include risk-benefit analysis. Yet these methodologies are sorely tested when applied to issues of sustainable development in general, and climate change in particular, because of the convergence of several factors: (1) long lead times; (2) significant

FIGURE 11



Source: U.S. CEQ

Table 9: American Greenhouse Gas Emissions and Sinks, 1990 and 1999 (Tg CO2 Eq.)

Gas/Source	**1990**	**1999**	**% change**
CO2	4,913.00	5,558.10	13%
Fossil Fuel Combustion	4,835.70	5,453.10	13%
Cement Manufacture	33.3	39.9	20%
Waste Combustion	17.6	26	48%
Lime Manufacture	11.2	13.4	20%
Natural Gas Flaring	5.1	11.7	129%
Limestone and Dolomite Use	5.1	8.3	63%
Soda Ash Manufacture and Consumption	4.1	4.2	2%
Carbon Dioxide Consumption	0.8	1.6	100%
Land-Use Change and Forestry (Sink) [a]	-1,059.90	-990.4	-7%
International Bunker Fuels [b]	114	107.3	-6%
CH4	644.5	619.6	-4%
Landfills	217.3	214.6	-1%
Enteric Fermentation	129.5	127.2	-2%
Natural Gas Systems	121.2	121.8	0%
Coal Mining	87.9	61.8	-30%
Manure Management	26.4	34.4	30%
Petroleum Systems	27.2	21.9	-19%
Wastewater Treatment	11.2	12.2	9%
Rice Cultivation	8.7	10.7	23%
Stationary Combustion	8.5	8.1	-5%
Mobile Combustion	5	4.5	-10%
Petrochemical Production	1.2	1.7	42%
Agricultural Residue Burning	0.5	0.6	20%
Silicon Carbide Production	+	+	n.a.
International Bunker Fuels [b]	+	+	n.a.
N2O	396.9	432.6	9%
Agricultural Soil Management	269	298.3	11%
Mobile Combustion	54.3	63.4	17%
Nitric Acid	17.8	20.2	13%
Manure Management	16	17.2	8%
Stationary Combustion	13.6	15.7	15%
Adipic Acid	18.3	9	-51%
Human Sewage	7.1	8.2	15%
Agricultural Residue Burning	0.4	0.4	0%
Waste Combustion	0.3	0.2	-33%
International Bunker Fuels [b]	1	1	0%
HFCs, PFCs, and SF6	83.9	135.7	62%
Substitution of Ozone Depleting Substances	0.9	56.7	6200%
HCFC-22 Production	34.8	30.4	-13%
Electrical Transmission and Distribution	20.5	25.7	25%
Aluminum Production	19.3	10	-48%
Semiconductor Manufacture	2.9	6.8	134%
Magnesium Production and Processing	5.5	6.1	11%
Total Emissions	6,038.20	6,746.00	12%
Net Emissions (Sources and Sinks)	**4,978.30**	**5,755.70**	**16%**

+ Does not exceed 0.05 Tg CO2 Eq.
a Sinks are only included in net emissions total, and are based partially on projected activity data.
b Emissions from International Bunker Fuels are not included in totals.

Note: Totals may not sum due to independent rounding.
Note: Parentheses indicate negative values (or sequestration).

Source: US EPA website

levels of scientific uncertainty; and (3) the extraordinary magnitude of potential impacts. (See, for example, D'Arge et al., 1982).

While most European nations have recognized and accepted the need for reductions in Greenhouse Gas (GHG) emissions, a vociferous debate continues in North America, focussing on what are perceived to be the inordinate costs of GHG reduction. Some of this debate has been framed and funded by special economic interest groups, tending inexorably to a diminution of scientific rigor and obfuscation of the subtleties of the issues. Depending on the source, estimates of reaching Kyoto targets in Canada, for example, range from a cost of $40 billion to a benefit of $5 billion. (den Elzen and de Moor, 2001; CME, 2002; Environment Canada, 2002; Globe & Mail, April 5 and 26, 2002; Tellus Institute and MRG&Associates, 2002).

The most pessimistic of these assumptions (provided by the Canadian Manufacturers & Exporters - CME) does not include cost reductions associated with new technologies or changing patterns of human activity – both of which may lead to greater GHG reduction per dollar spent. Even if such cost estimates were proven to be correct, however, the exercise lacks relevance without considering the offsetting benefits – here equal to the potentially enormous ecological damages avoided and their associated economic impact. The problem of assessing the long-term economic impact of global warming is exacerbated by the inherently easier task of measuring immediate control costs, as opposed to medium- to longer-term benefits.

The most recent American government study (U.S. Dept. of State, 2002), while finally recognizing the linkage between human activity and GHG, recommends a passive policy response on at least two grounds: first, it is too late to respond and, second, the anticipated ecological costs are accompanied by some tangible benefits. To quote:

> Sea level rise at mid-range rates is projected to cause additional loss of coastal wetlands, particularly in areas where there are obstructions to landward migration, and put coastal communities at greater risk of storm surges, especially in the southeastern United States. Reduced snowpack is very likely to alter the timing and amount of water supplies, potentially exacerbating water shortages, particularly throughout the western United States, if current water management practices cannot be successfully altered or modified. Increases in the heat index (which combines temperature and humidity) and in the frequency of heat waves are very likely. . . .
>
> Some potential benefits were also identified in the assessments. For example, due to increased carbon dioxide (CO_2) in the atmosphere and an extended growing season, crop and forest productivities are likely to increase where water and nutrients are sufficient, at least for the next few decades. As a result, the potential exists for an increase in exports of some U.S. food products, depending on impacts in other foodgrowing regions around the world. Increases in crop production in fertile areas could cause prices to fall, benefiting consumers. Other potential benefits could include extended seasons for construction and warm-weather recreation, and reduced heating requirements and cold-weather mortality.

Despite the list of potential benefits cited in this report, it fails to acknowledge that the anticipated costs will probably be permanent, while the benefits transitory in the face of a passive response to global warming. Nor does the proposed policy of passive response satisfactorily address the aforementioned threat of abrupt shifts in ecological states.

In the area of risk-benefit analysis, a model developed several years ago by the U.S. Nuclear Regulatory Commission to reflect the public's perception of large nuclear disasters may be particularly germane to the question of climate change. The NRC's "alpha model" produces an "equivalent social cost" where the standard measure of risk - normally represented as the product of accident frequency and consequences - is modified by the inclusion of an exponent (alpha) on the consequence term, where alpha > 1.0. This is one methodology for capturing in mathematical terms the risk aversion characteristic of the precautionary principle.

Ultimately, fundamental concepts of accounting – both public and private sector – are essential to the achievement of sustainable development, for it is accounting, broadly defined, which generates measures of performance by which movement toward or away from sustainability can be gauged.

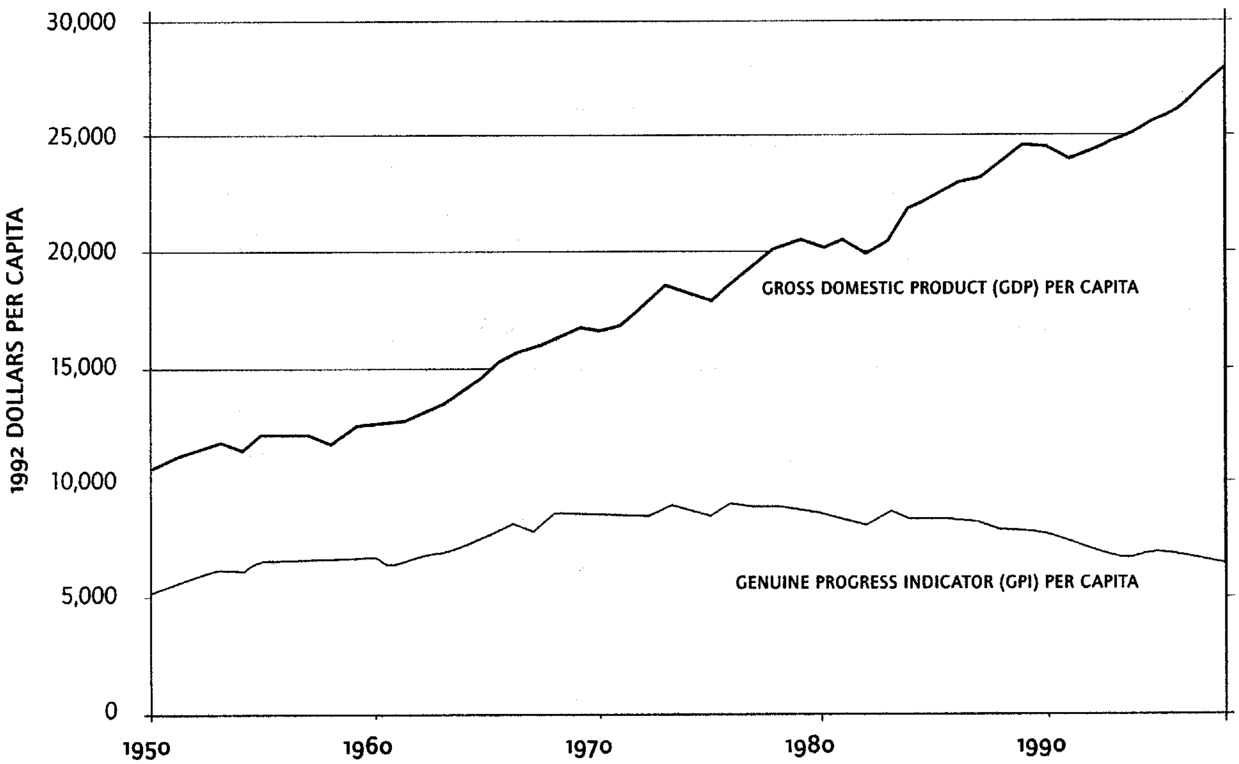
The late Robert Eisner of Northwestern University was one of the first economists to study the dysfunctional accounting practices of the U.S. and other governments. No corporation would survive if it adopted public sector accounting principles which fail to differentiate between consumption and investment. Eisner recalculated the federal budget by changing the treatment of such important social investments as education, research & development and infrastructure. By capitalizing such expenditures rather than expensing them, Eisner (1994) demonstrated that the budget deficit in that year had been overstated by a factor of eight.

Several initiatives have already been undertaken to address these profound deficiencies in macroeconomic indicators such as GNP and GDP. For example, efforts have been underway over the last decade to broaden the definition of national accounts to include not only physical capital, but also natural and human capital. (See, for example, Ahmad et al.,1989; UN, 1993; Lutz, 1993; Serageldin and Steer, 1993; CBO, 1994; Van Dieren, 1995; Rodenburg et al., 1995; Nordhaus and Kokkelenberg, 1999). Repetto et al. (1989) succinctly summarized the problem of dysfunctional national accounting in an early report from the World Resources Institute when they stated: "A country could exhaust its mineral resources, cut down its forests, erode its soil, pollute its aquifers, and hunt its wildlife to extinction, but measured income would not be affected as these assets disappeared."

In addition, several systems of social accounting have emerged from academic and quasi-academic institutions in the United States. Included among these are Daly and Cobb's (1994) Index of Sustainable Economic, Miringoff and Miringoff's Social Health Indicators (1999) and the Genuine Progress Indicator (GPI) produced by Redefining Progress of San Francisco. The GPI is a recalculated GDP which distinguishes "bads" (i.e. expenditures related to such items as pollution, crime, accidents, etc.) from "goods." Under current national income principles, all "bads" are treated as positive contributions to GDP. Redefining Progress (1999) generated GPI per capita for the United States and compared it with the conventional measure of GDP per capita for the last half of the Twentieth Century. The result, portrayed in **Figure 12**, suggests a startlingly different trend between the two measures. Parallel research has been undertaken for Canada in Alberta and Nova Scotia (Dodds and Colman, 2002; Anielski, 2002).

As stated above, the achievement of sustainable development depends critically on the existence of performance indicators, and several national and international studies have already been undertaken to identify a list of appropriate metrics. A widely-used indicator, termed "the Ecological Footprint," calculates the land area required to produce the physical stocks of capital necessary to sustain a given human population and absorb their waste discharges, and then compares this

FIGURE 12



value with the area which the population inhabits – whether a city, state or country. Conceptually, this model is more appropriate for national and global assessment than it is for urban areas. The application of the Ecological Footprint to cities fails to recognize the symbiotic relationship between an urban area and its hinterland, and penalizes more densely populated areas which are more ecologically efficient than cities characterized by urban sprawl.

As **Table 10** demonstrates, virtually all developed nations of the world have an ecological footprint significantly larger than their geographic area. (See also WWF et al., 2002.) These appropriated resources come from other countries, are "borrowed from the past (e.g., as fossil energy) or permanently appropriated from the future (e.g., in the form of contamination, plant growth reduction through reduced UV radiation, soil degradation, etc.)" (Wackernagel and Rees, 1996; Wackernagel et al., 1997; Wackernagel, 2001) The implication of this concept for sustainable development at the global level is significant in light of continuing pressure for economic development, To quote the authors: "If everybody lived like today's North Americans, it would take at least two additional planet Earths to produce the resources, absorb the wastes, and otherwise maintain life-support."

A number of government policies have facilitated the adjustment of corporate strategy toward more environmentally friendly processes and procedures while achieving significant cost savings. Prominent among these is the replacement of classical regulatory systems with economic incentives such as the market for tradable SO_2 emission permits in the United States (Ellerman et al.,

TABLE 10: THE ECOLOGICAL FOOTPRINT OF NATIONS

Country	footprint in [ha/cap]	available capacity in [ha/cap]	ecological deficit (if negative) in [ha/cap]		footprint in [ha/cap]	available capacity in [ha/cap]	ecological deficit (if negative) in [ha/cap]
Singapore	7.2	0.1	-7.1	**Denmark**	5.9	5.2	-0.7
Hong Kong	6.1	0.0	-6.1	**Philippines**	1.5	0.9	-0.6
Belgium	5.0	1.3	-3.7	**Czech Rep**	4.5	4.0	-0.5
Netherlands	5.3	1.7	-3.6	**China**	1.2	0.8	-0.4
United States	10.3	6.7	-3.6	**Ethiopia**	0.8	0.5	-0.3
United Kingdom	5.2	1.7	-3.5	**India**	0.8	0.5	-0.3
Germany	5.3	1.9	-3.4	**Pakistan**	0.8	0.5	-0.3
Japan	4.3	0.9	-3.4	**Bangladesh**	0.5	0.3	-0.2
Switzerland	5.0	1.8	-3.2	**Costa Rica**	2.5	2.5	0.0
Israel	3.4	0.3	-3.1	**France**	4.1	4.2	0.1
Italy	4.2	1.3	-2.9	**Norway**	6.2	6.3	0.1
Korea, Rep.	3.4	0.5	-2.9	**Malaysia**	3.3	3.7	0.4
Greece	4.1	1.5	-2.6	**Ireland**	5.9	6.5	0.6
Russian Fed.	6.0	3.7	-2.3	**Argentina**	3.9	4.6	0.7
Poland, Rep.	4.1	2.0	-2.1	**Chile**	2.5	3.2	0.7
South Africa	3.2	1.3	-1.9	**Sweden**	5.9	7.0	1.1
Jordan	1.9	0.1	-1.8	**Indonesia**	1.4	2.6	1.2
Spain	3.8	2.2	-1.6	**Canada**	7.7	9.6	1.9
Thailand	2.8	1.2	-1.6	**Colombia**	2.0	4.1	2.1
Mexico	2.6	1.4	-1.2	**Finland**	6.0	8.6	2.6
Venezuela	3.8	2.7	-1.1	**Brazil**	3.1	6.7	3.6
Austria	4.1	3.1	-1.0	**Australia**	9.0	14.0	5.0
Egypt	1.2	0.2	-1.0	**Peru**	1.6	7.7	6.1
Hungary	3.1	2.1	-1.0	**New Zealand**	7.6	20.4	12.8
Nigeria	1.5	0.6	-0.9	**Iceland**	7.4	21.7	14.3
Portugal	3.8	2.9	-0.9				
Turkey	2.1	1.3	-0.8	**WORLD**	**2.8**	**2.1**	**-0.7**

Source: Wackernagel et al. (2001)

2000; McLean, 2002.) A proposal to create a similar global market for greenhouse gas emissions is incorporated in the Kyoto Protocol, although the economic and political issues are considerably more complex at the international level. Not the least of these problems is the exemption of most of the developing nations from GHG reductions, despite the fact that much of the anticipated growth in global GHG emissions will come from the Third World (Richter, 2002; see also Table 5).

Some of the most innovative advances have occurred in the OECD where issues of environmental control and sustainable development are being addressed by at least four divergent policy mechanisms: (i) economic instruments such as environmental taxes and tradable permits; (ii) promotion of extended producer responsibility; (iii) green public purchasing; and (iv) encouragement of voluntary approaches by the private sector. Brief comments follow on each of these mechanisms.

Environmentally-related taxes

Table 11 summarizes recent OECD information on the use of such taxes, such as air pollution fees, load-based licensing schemes, incentive taxes, charges on chemicals and equipment, duties, water pollution fees and effluent charges, sewage treatment fees, duties and taxes on pesticides and artificial fertilizers, waste deposit, collection and treatment fees and levies, remediation charges, landfill taxes, charges on batteries, packaging, oil recycling, paints, plastic and paper bags, certain industrial chemicals, tires, nuclear waste, oil waste, beverage containers, litter control, antibiotics and growth promoters, fuel taxes, and carbon dioxide taxes. (Sources: OECD, 2001a, 2002-database; see also O'Riordan, 1997.) Many of these initiatives have been implemented under the general rubric of green or ecological tax reform. The fundamental goal of such policies is to protect the environment and promote sustainability while enhancing economic efficiency by shifting the burden of taxation to ecologically harmful activities while attempting to preserve tax neutrality (Barde, 2002). [See also CES, 2002, for a list of European policies to promote the development and utilization of more sustainable technologies.]

Promotion of extended producer responsibility

The OECD (2001b, p. 9) defines extended producer responsibility (EPR) as: "a policy approach in which producers accept significant responsibility (financial and/or physical) for the treatment or disposal of post-consumer products. Assigning such responsibility could provide incentives to prevent wastes at source, promote environmentally compatible product design and support the achievement of public recycling and materials management goals." EPR instruments fall into three general categories: take-back requirements, economic instruments (deposit/refund schemes, advance disposal fees, material taxes, upstream combination tax/subsidy), and performance standards (such as minimum recycled content). Other measures include: "unit based pricing of household waste (by volume/weight); landfill bans and taxes; removal of virgin material subsidies; materials, product and chemical bans and restrictions; eco-labelling; green government purchasing, marketable permits, and recycling credit programmes (p. 12)."

Perhaps the best known example of this type of program is Germany's Green Dot System which requires producers to "close the loop" on products as large as private automobiles and accept the return of the product at the end of its useful life (US EPA, 1994 and http://www.gruener-punkt.de/en/home.php3).

Green public purchasing

The third leg of OECD's diverse policy agenda to reduce environmental disruption and move towards sustainable development focuses on the purchase of green products and services by government. There are two distinct components to this strategy. The first is assisting purchasers "in their ability to identify a product or service, establish a solicitation document, and select a product to set a contract. Typically these tools may be: product standards, environmentally preferable product criteria, environmental labelling, and guiding principles (OECD, 2000, p. 48)." More specifically, these include single-issue labels, life-cycle assessments, ecolabelling, provision of purchasing guidebooks, and the favouring of companies with environmental management systems.

The second strategic component includes policies and tools which "set the framework con-

Table 11: MATRIX OF OECD TAXES

TAXES ON:	artificial fertilizer release in non-point sources	BOD, COD	effluent collection and treatment	hazardous chemicals	leaded petrol	NOx	other air emissions	other water pollutants	Ozone depleting substance	pesticide release in non-point sources	waste management - in general	waste management - individual products
Australia		X			X		X	X	X		X	X
Austria								X	X		X	X
Belgium					X			X		X		X
Canada				X	X		X	X		X	X	X
Czech Republic		X				X	X	X	X		X	
Denmark	X	X		X	X				X	X	X	X
Finland					X			X		X	X	X
France								X			X	
Germany					X			X			X	
Greece					X			X			X	
Hungary					X		X	X	X		X	X
Iceland												X
Ireland					X							
Italy						X		X			X	X
Japan											X	
Korea							X	X			X	X
Luxembourg					X							
Mexico					X			X				
Netherlands		X	X		X			X			X	X
Norway				X	X			X		X	X	X
Poland		X			X	X	X	X	X		X	X
Portugal												
Slovak Republic		X				X	X	X	X		X	X
Spain								X				
Sweden	X					X		X	X	X	X	
Switzerland					X		X				X	X
Turkey								X				
UK					X						X	
USA		X		X			X	X	X		X	X

SOURCE: OECD On-line database of environmentally-related taxes ditions because they affect the entire purchasing process and the institutional structure that supports the framework." The focus is on influencing management practices such as "organisational procedures that influence purchasing practices (such as career development criteria), how spending decisions are made (the purchasing officer may have influence over the decision), organisational context (i.e. control and audit mechanisms). . . . [and] budgeting / financing mechanisms that determine the economic foundation of a procurement decision, either at the up-hill stage when setting a tender (i.e. justifying a decision to spend), or while selecting the bidders (i.e. choosing the appropriate solution)." Also included are "Regulatory / statutory issues generally defined in procurement legislation with the aim of achieving transparency and favouring healthy competition between bidders while avoiding trade distortions (p. 76)."

Encouragement of voluntary approaches by the private sector

The final category of government initiated or mediated approaches to environmental control focuses on encouraging firms to voluntarily undertake activities which lead to environmental performance above those levels mandated by law. The OECD (1999, pp. 9-10) identified four types of such voluntary approaches: "Public voluntary programmes [which] involve commitments devised by the environmental agency and in which individual firms are invited to participate. . . . Negotiated agreements [which] involve commitments for environmental protection developed through bargaining between a public authority and industry. . . . Unilateral commitments [which] are set by the industry acting independently without any involvement of a public authority. . . . [and] private agreements [which are] reached through direct bargaining between . . .polluters and pollutees."
Over three hundred such agreements have been negotiated in the European Union in the agricultural, energy and industrial sectors. They address virtually all areas of environmental concern, including climate change, water pollution, waste management, air pollution, soil quality and ozone depletion (OECD, 1999, pp. 51-52).

In conclusion, it is apparent that a vast array of policy instruments has emerged from the governmental sector within the last two decades. Many of these instruments and initiatives have been the result of a creative re-examination and re-conceptualization of traditional regulatory systems. Considerable efforts have been made to move away from a system of command and control which has been economically inefficient and often legally ineffective. Efforts have been made to craft a framework which creates both opportunities as well as constraints for industry, and which permits individual companies to respond in a manner which allows them to achieve both social goals and corporate financial objectives in as efficient a manner as possible. Ultimately, however, it is upon the shoulders of the private sector, as producers and consumers, to move society closer to the path of sustainable development. Government policies are designed to establish the framework within which corporations must operate; corporations must develop their own internal mechanisms to respond to the challenge.

PART IV: OPERATIONALIZING SUSTAINABLE DEVELOPMENT – CORPORATE SECTOR TOOLS

As in the public sector, accounting concepts and practices are central to the corporate sector's drive for sustainability. Why should a company develop and adopt a system of ecological (or green) accounting? As Schaltegger and Burritt (2000, p. 407) state, "one reason why companies are taking the need for ecological accounting seriously is increased stakeholder and regulator pressure." In a sense, the modern corporation, despite its aura of omnipotence, is fundamentally hostage to the values of all its stakeholders, whether they are shareholders, employees, suppliers, customers, creditors, insurers or the general public. Each of these stakeholder groups can ultimately determine the success or failure of a corporation.

Traditionally, the corporation could meet its stakeholder obligations through the application of sound business practices which addressed internal corporate issues such as product offerings and cost control with subsequent maximization of profits and shareholder returns. In contrast, the modern corporation must meet a much broader range of economic, ecological and social obligations which are intimately tied to all activities of the corporation and the production, distribution and ultimate disposition of its products. As such, there are irresistible reasons for companies to address issues of sustainable development in the formation and implementation of corporate strategy. As Schaltegger and Burritt (2000, p. 408) state, "like it or not, ecological and financial issues will be integrated, and establishment of internal and external ecological accounting systems will become a priority, not just for the leaders, the large multinationals that have expertise to throw at these problems, but also for the small and medium-sized businesses."

The U.S. Environmental Protection Agency (1995, pp. 1-2) enumerates seven reasons why environmental cost and performance deserve management attention:

> (1) Many environmental costs can be significantly reduced or eliminated as a result of business decisions, ranging from operational and housekeeping changes, to investment in "greener" process technology, to redesign of processes/products. Many environmental costs (e.g., wasted raw materials) may provide no added value to a process, system, or product.
> (2) Environmental costs (and, thus, potential cost savings) may be obscured in overhead accounts or otherwise overlooked.
> (3) Many companies have discovered that environmental costs can be offset by generating revenues through sale of waste by-products or transferable pollution allowances, or licensing of clean technologies, for example.
> (4) Better management of environmental costs can result in improved environmental performance and significant benefits to human health as well as business success.
> (5) Understanding the environmental costs and performance of processes and products can promote more accurate costing and pricing of products and can aid companies in the design of more environmentally preferable processes, products, and services for the future.
> (6) Competitive advantage with customers can result from processes, products, and services that can be demonstrated to be environmentally preferable.
> (7) Accounting for environmental costs and performance can support a company's development and operation of an overall environmental management system. Such a system will soon be a necessity for companies engaged in international trade due to pending international consensus standard ISO 14001, developed by the International Organization for Standardization.

There is a vast array of environmental costs incurred by firms, including such diverse categories as regulatory, upfront, voluntary, back-end, contingent and image and relationship costs. [See **Table 12**.] Many of these costs can be potentially hidden, with serious consequences for the profitability for a corporation. One of the earliest and most insightful reports on this subject was produced by the World Resources Institute in 1995 and authored by Ditz et al. under the title *Green Ledgers: Case Studies in Corporate Environmental Accounting.* The basic theme of this book is that the lack of recognition of the true magnitude and location of all environmental costs in a corporation prevents it from making intelligent resource allocation decisions. Most importantly, lack of information about these costs forecloses important strategic opportunities for the firm. One major consequence of a firm's ignorance of the extent and location of environmental costs borne by the company is that "products with relatively higher environmental costs are often subsidized by those with lower ones." Products which may appear profitable can impose significant environmental costs on other parts of the business and such costs are not attributed to their original source. This introduces

Table 12: FIRM-LEVEL ENVIRONMENTAL COSTS (SOURCE: USEPA, 1995)

	POTENTIALLY HIDDEN COSTS	
Regulatory	**Upfront**	**Voluntary (Beyond Compliance)**
Notification	Site studies	Community relations/outreach
Reporting	Site preparation	Monitoring/testing
Monitoring/testing	Permitting	Training
Studies/modeling	R&D	Audits
Remediation	Engineering & procurement	Qualifying suppliers
Recordkeeping	Installation	Reports (annual environmental)
Plans		Insurance
Training	**Conventional Costs**	Planning
Inspections		Feasibility studies
Manifesting	Capital equipment	Remediation
Labeling	Materials	Recycling
Preparedness	Labour	Environmental studies
Protective equipment	Supplies	R&D
Medical surveillance	Utilities	Habitat and wetland protection
Environmental	Structures	Landscaping
Insurance	Salvage value	Other environmental projects
Financial assurance		Fin. support to environ. groups
Pollution control	**Back-end**	Financial support to researchers
Spill response		
Stormwater management	Closure/decommissioning	
Waste management	Disposal of inventory	
Taxes/fees	Post-closure care	
	Site Survey	
	CONTINGENT COSTS	
Future compliance costs	Remediation	Legal expenses
Penalties/fines	Property damage	Natural resource damages
Response to future releases	Personal injury damage	Economic loss damages
	IMAGE AND RELATIONSHIP COSTS	
Corporate image	Relationship with professional staff	Relationship with lenders
Relationship with customers	Relationship with workers	Relationship with host communities
Relationships with investors	Relationship with suppliers	Relationship with regulators
Relationship with insurers		

a major distortion in the process of profit maximization through efficient resource allocation decisions at the margin. Certain products or processes may be encouraged/discouraged on the basis of such incorrect price signals within the corporation.

Environmental accounting has a crucial role to play in both financial and managerial accounting. In the latter case, this focusses on three critical areas: (1) cost allocation to increase profitability, (2) capital budgeting to recognize financially attractive investments, and (3) process/product design to affect environmental costs and performance.

The adoption of environmental accounting systems ultimately requires a fundamental reconceptualization of the flows of goods and service through an organization and the costs associated therewith as well as the interaction of the firm with its political, social, economic and ecological environment. In an insightful analysis reflective of the principles of ecological economics, Rubenstein (1994, pp. 191, 194) speaks of the necessity of accounting for "noncommercial facets of an ecosystem upon which the company is economically dependent . . . . for every corporate asset there is an invisible, shadow ecological asset and liability."

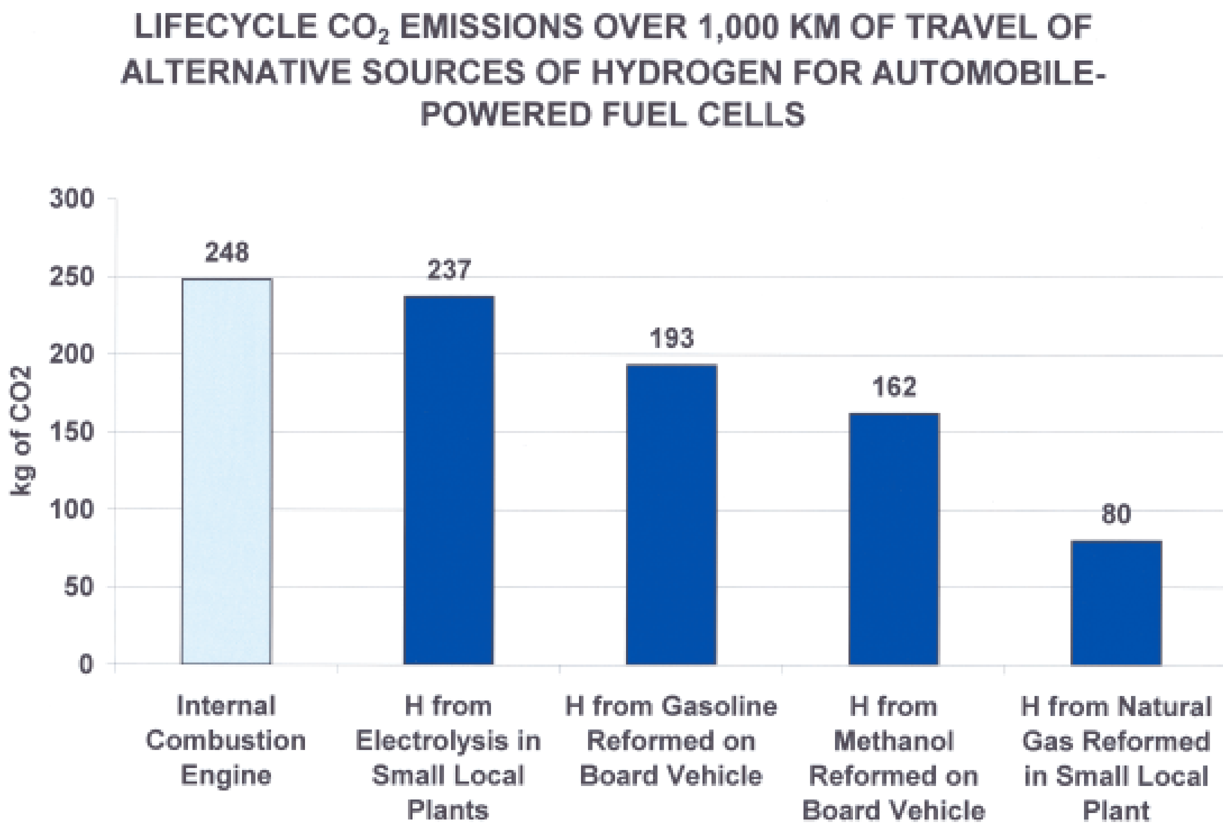
The process of integrating principles of ecological accounting into corporate accounting systems remains a work in progress both conceptually and empirically, but there are several important methodologies which have emerged to facilitate this process. Two of these are industrial ecology and eco-efficiency.

Industrial Ecology (Nordic Council of Ministers, 1992; Graedel and Allenby, 1995; Ayres and Ayres, 1996; McDonough and Braungart, 2002) essentially visualizes the operation of a firm as a living organism, absorbing and metabolizing (i.e. processing) inputs and generating outputs, including wastes. With this theoretic as a guiding principle, it is easier to see that the generation of unnecessary wastes - a process alien to nature - is economically inefficient and ultimately represents lost profits to the corporation. One of the major tools from Industrial Ecology is life-cycle analysis (and its economic counterpart, life-cycle cost analysis) which produces a comprehensive picture of the environmental impact (and cost) of a product from "cradle to grave." The use of this methodology can occasionally lead to unexpected results, suggesting for example that disposable diapers may be preferable to cloth, and that plastic cups may be preferable to paper (Hocking, 1991, 1993). Consider the effect of applying LCCA to propulsion systems in the automotive sector.

Case Study #4: **Are Alternative Automotive Propulsion Systems Sustainable?**

In recognition of the considerable externalities associated with the internal combustion engine which powers most motor vehicles, new government and corporate emphasis has been placed on developing alternative propulsion systems, from electric cars to automobiles powered by fuel cells. Several recent studies have applied life-cycle cost analysis to these alternatives with somewhat surprising results. Graedel and Allenby (1995) compared life cycle energy use and greenhouse gas emissions from automotive propulsion systems based on fossil fuel electricity and conventional internal combustion. On the basis of this systems analysis of two important variables, the authors found no appreciable differences between gasoline and electricity. **Figure 13** compares alternative sources for hydrogen as a power source for fuel cells in automobiles (Pembina Institute and David Suzuki Foundation, 2001). The results clearly demonstrate the value of applying systems analysis (in the form of LCA) to the important issue of transportation. Such analysis helps to determine

FIGURE 13



which alternatives are more sustainable (or less unsustainable) than others.

The second major methodology available to the corporate sector to facilitate the move towards sustainable development is Eco-efficiency (Fussler and James, 1996; DeSimone and Popoff, 1997; NRTEE, 1999; WBCSD, 2000a,b) conceived by the World Business Council for Sustainable Development - a pioneering business-based group which has championed such important concepts as the “triple-bottom line” (See, for example, Schmidheiny, 1992). The Council (2002a) defines eco-efficiency as:

> . . .a management philosophy which encourages business to search for environmental improvements that yield parallel economic benefits. It focuses on business opportunities and allows companies to become more environmentally responsible and more profitable. It fosters innovation and therefore growth and competitiveness. . . . Eco-efficiency is 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. In short, it is concerned with creating more value with less impact.

There are three broad objectives of Eco-efficiency (WBCSD, 2000): (1) reducing the consumption of resources; (2) reducing the impact on nature; and (3) increasing product or service value. In addition, "many companies have a fourth objective, namely implementing an Environmental or Sustainability Management." There are four areas in which opportunities are new Eco-efficiency can be found:

> First, companies can re-engineer their processes to reduce the consumption of resources, reduce pollution and avoid risks, while at the same time saving costs. Second, by cooperating with other companies, many businesses have found creative ways to re-valorize their byproducts. In striving for zero-waste or 100%-product targets, they have found that the so-called waste from their processes can have value for another company. Thirdly, companies can become more eco-efficient by redesigning their products. Fourth, some innovative companies not only redesign a product, they find new ways of meeting customer needs. They work with customers or other stakeholder groups to re-think their markets and re-shape demand and supply completely. Too many customers needs today are met in a material- and energy-intensive way. There are different, and better, ways of satisfying those needs.

The successful implementation of the eco-efficiency concepts depends ultimately on the development of workable performance indicators which can signal to the corporation whether it is moving closer to or away from sustainability. The World Business Council has invested a significant amount of intellectual resources into the creation of a set of eco-efficiency metrics (WBCSD, 2000b). They fall into two complementary categories: (1) those generally applicable to all business, and (2) those which are business-specific.

Eco-efficiency is formally defined as the quotient of product or service value and environmental influence, where the numerator can be measured by quantity of goods or services or net sales, and the denominator by such variables as the consumption of energy, materials or water, and emissions of greenhouse gases or ozone depleting substances. The Business Council (p. 3) also feels that acid rain precursors and total waste might be considered as appropriate denominators pending global agreement on measurement methods. It is the Council's recommendation that such data can be presented as "absolute figures, eco-efficiency ratios, indexed to a selected year, or expressed relative to a projected goal. The performance could also be expressed relative to an industry average."

Another promising tool to aid corporate decision making for sustainability *and* profitability is called "The Natural Step." Formulated by two Europeans, Dr. Karl-Henrik Robert and Dr. John Holmberg, this principle was introduced into North America by Paul Hawken. It was the goal of Dr. Robert to translate ecological principles into a form which could be implemented at the corporate level (Robert, 2002).

As described by Nattrass and Altomare, (1999), The Natural Step includes four core processes: "Perceiving the nature of the unsustainable direction of business and society and the self-interest implicit in shifting to a sustainable direction; understanding the first-order principles for sustainability (i.e. the four System Conditions); strategic visioning through 'back-casting' from a desired sustainable future; and identifying strategic steps to move the company from its current reality toward its desired vision."

To achieve sustainability within the Natural Step framework, nature's functions and diversity must *not* be systematically "subject to increasing concentrations of substances extracted from the Earth's crust; subject to increasing concentrations of substances produced by society; and impoverished by overharvesting or other forms of ecosystem manipulation." In addition, the conditions require that "resources are used fairly and efficiently in order to meet basic human needs worldwide."

The effectiveness of The Natural Step flows from the ability to directly translate these principles into corporate policy. Nattrass and Altomare (2002a) list eight concepts which facilitate the translation of the principal "system conditions" into action:

1. Renewable: Change over to renewable raw materials and energy sources (System Condition one).
2. Degradable: Use substances and materials that are easily broken down in nature and converted into new resources (System Condition two).
3. Sortable: Construct products so that the constituent materials can be easily separated for recycling (System Condition four).
4. Nature: Refrain from all unnecessary intrusions into nature and the ecocycle (System Condition three).
5. Save: Always ask yourself whether you can avoid or cut back on your use of resources (System Condition four).
6. Quality: Choose products with a long useful life, which can be repaired if they break (System Condition four).
7. Efficiency: Plan use of materials, energy, technology, and transport to achieve maximum benefit for minimum expenditure of resources (System Condition four).
8. Reuse: The greatest savings in our use of resources can be achieved by reusing them (System Condition four):
   a. Reusing products (i.e., using the same product several times).
   b. Recycling materials (i.e., using used material as raw material for a new product).
   c. Incinerating materials to release the energy content, such as using for heating purposes. This is only acceptable if the gases emitted are such that nature can deal with them. Dumping waste on garbage tips or pumping it into rivers, lakes, and seas is not an alternative in a sustainable society.

Some of the major corporations which have successfully adopted The Natural Step and captured a competitive advantage as a result include IKEA, Scandic Hotels, Interface Inc, and Collins Pine Company (Nattrass & Altomare, 1999; 2002b).

In addition, there are a broad array of additional tools available to management under the general rubric of environmental management systems and related national and international standards such as the British BS7750 and ISO 14001, 14010s, 14020s and 14031 (Hunt and Johnson, 1995; Sharratt, 1995; Hillary, 1997; Kuhre, 1995, 1996, 1997, 1998).

In light of the conceptual challenges to modifying traditional accounting systems to integrate ecological considerations, many corporations have adopted a preliminary step by issuing "sustainability reports" that complement their conventional financial reporting and which include environmental and social information relating to firm performance and impact. These reports may be internally-generated or the product of third-party audits. In one major survey of 996 companies, Switzerland-based SAM Sustainable Asset Management (Holliday et al., 2002, p. 23) found that approximately half publish both environmental and social information, but only one-third provide information which includes all their operations.

The breadth, depth and usefulness of information provided in corporate environmental reports can vary widely. **Table 13** provides a summary of variables which have been included in recent reports within Canada (Coady, personal communication).

Table 13: SURVEY LIST OF MATERIAL COVERED IN CORPORATE ENVIRONMENTAL REPORTS

MANAGEMENT POLICIES AND SYSTEMS
Top Management Statement
Environmental Policy Statement
Environmental Management System
Management Responsibilities
Environmental Auditing
Goals and Targets
Legal Compliance
Research and Development
Programs and Initiatives
Awards
Third Party Verification
Reporting Policy
Corporate Context
Glossary
Feedback Card

INPUT/OUTPUT INVENTORY
Material Use
Energy Consumption
Water Consumption
Health and Safety
Accidents and Emergency Response
Land Contamination and Remediation
Fish and Wildlife Habitats
Wastes
Air Emissions
Water Effluents
Noise and Odour
Life-cycle design
Product impacts

FINANCE
Environmental spending
Environmental cost accounting
Charitable contributions

STAKEHOLDER RELATIONS
Employees
Legislators and Regulators
Local Communities
Industry Associations
Environment Groups
Science and Education

SUSTAINABLE DEVELOPMENT
Global environmental issues
Technology cooperation
Global operating standards

Source: Linda Coady, personal communication

SUSTAINABLE DEVELOPMENT WITHIN THE BUSINESS COMMUNITY

There are numerous outstanding examples of corporations from a broad range of industries which have adjusted their corporate strategy to recognize and capitalize on principles of sustainable development (Denton, 1994; McInerney and White, 1995; US PCSD, 1997; Romm, 1999; Margolick and Russell, 2001; Robbins, 2001; McCann, 2002; Nemetz, 2002a,b; Suzuki and Dressel, 2002; Young et al., 2002). Some of this reconceptualization and realignment of strategy has been facilitated by initiatives undertaken by industry associations. Among the most prominent of these, despite its critics (King and Lenox, 2000), is the "Responsible Care" program of the International Council of Chemical Associations in which "companies, through their national associations, commit to work together to continuously improve the health, safety, and environmental performance of their products and processes, and so contribute to the sustainable development of local communities and of society as a whole (ICCA, 2002)."

Two remarkable corporate case studies lend credence to the hypothesis that the reconceptualization of business can indeed contribute to both profitability and sustainable development.

Case Study #5 - BP Ltd.

As the energy sector, encompassing extraction, production and use, is the largest single contributor to greenhouse gas emissions in the world (See **Table 9**), it poses large and complex challenges in the reduction of these pollutants. It is for this reason that significant reductions in GHGs by one of its major players is particularly noteworthy and auspicious. BP, the world's second largest integrated producer of energy and petrochemicals with sales in excess of $165 billion USD, recently announced that it had voluntarily achieved significant GHG reductions. To quote its press release of March 11, 2002 (www.bp.com):

> BP today announced that it has reduced its greenhouse gas emissions by over nine million tonnes eight years ahead of target, and said it will peg net future emissions at this new, lower level despite plans to grow its oil and gas production by 5.5 per cent a year. Chief executive Lord Browne said that BP's pledge, made four years ago, to cut emissions from its own operations by ten per cent from 1990 levels by 2010 had already been achieved - and at no net cost to the company. Speaking at Stanford University, in California, Browne said BP's target now was to contain net emissions at current levels through the next decade. This would be done partly through a mix of internal actions, principally the more efficient use of energy across the company's operations. It would also entail the use of carbon credits resulting from the company's accelerated shift to natural gas and other lower-carbon products, as well as cleaner transport fuels and lubricants essential to the development of lower-emission engines.

Case Study #6 - Interface Ltd.

The advent of the post-industrial (or information) age, has been marked by a major change in the conceptualization of the traditional distinction between goods (physical commodities) and services (intangible products). The essence of this reconceptualization rests on the realization that most of the physical commodities we buy are not bought as commodities per se, but for the services they provide. This change in paradigm has potentially profound implications for the advancement of sustainability. Examples abound on the world wide web, where companies have replaced many physical products by their electronic equivalent. In the field of industrial manufacturing, however, this accomplishment is considerably more challenging. One company, Interface, Inc., provides an illustration of how revolutionary this reconceptualization of normal business practices can be. The world's largest manufacturer of commercial carpet – with a large petrochemical component – Interface conceived of the idea of leasing a floor covering service rather than selling carpets. As described by Lovins et al., (2002), the company:

> . . . leases a floor-covering service for a monthly fee, accepting responsibility for keeping the carpet fresh and clean. Monthly inspections detect and replace worn carpet tiles. Since at most 20% of an area typically shows at least 80% of the wear, replacing only the worn parts reduces the consumption of carpeting material by about 80%. It also minimizes the disruption that customers experience -- worn tiles are seldom found under furniture. Finally, for the customer, leasing carpets can provide a tax advantage by turning a capital expenditure into a tax-deductible expense. The result: the customer gets cheaper and better services that cost the supplier far less to produce. Indeed, the energy saved from not producing a whole new carpet is in itself enough to produce all the carpeting that the new business model requires. Taken together, the 5-fold savings in carpeting material that Interface achieves through the Evergreen Lease and the 7-fold materials savings achieved through the use of Solenium [a new carpet fabric developed by Interface] deliver a stunning 35-fold reduction in the flow of materials needed to sustain a superior floor-covering service. Remanufacturing, and even making carpet initially from renewable materials, can then reduce the extraction of virgin resources essentially to the company's goal of zero. [See also Ottman, 2002].

The website of the World Business Council on Sustainable Development provides 65 additional case studies of international companies which have applied sustainability concepts to their business practices (www.wbcsd.ch/casestud/index-list.htm). Two seminal works by Michael Porter and Claas van de Linde (1995) and Paul Hawken with Amory and Hunter Lovins (1999) demonstrate that these types of innovative approaches to business not only help to protect the environment, but can also lead to increased corporate profitability by establishing a sustainable competitive advantage. Central to the achievement of these changes is a fundamental re-examination of old nostrums and a willingness to adopt new and what may appear on the surface to be radical approaches. (See, for example, Reed, 2001).

Numerous organizations – both non-profit and business-based – have emerged to assist the corporate sector in this process of reorientation. Australia's ECOS corporation is one such entity (Hogarth, 2002). Another prominent organization is the aforementioned World Business Council on Sustainable Development. The advantages of having such consulting firms and organizations available to assist corporations in the difficult task of addressing issues of sustainable development are cogently illustrated by Monsanto whose efforts went seriously awry.

Case Study #7 - Monsanto

In 1995, Robert Shapiro became Chairman and President of Monsanto, one of the world's largest chemical manufacturers. Within the previous decade, the company had started a major strategic shift away from reliance on pollutant-intensive, bulk chemical commodities toward value-added and research-intensive, biotechnology products with a particular focus on the agricultural and food sectors. Monsanto had decided to become what it termed a "life sciences" rather than a chemical company.

This strategic redirection was given a major impetus with the ascension to office of Shapiro, who had previously been President and CEO of Nutra Sweet Co., a subsidiary of Monsanto. Shapiro was without a doubt a visionary. The extent of his strategic creativity was demonstrated in an interview he gave to the Harvard Business Review (Magretta, 1997):

> Today there are about 5.8 billion people in the world. About 1.5 billion of them live in conditions of abject poverty. . . . Without radical change, the kind of world implied by those numbers is unthinkable. It's a world of mass migrations and environmental degradation on an unimaginable scale. At best, it means the preservation of a few islands of privilege and prosperity in a sea of misery and violence. Our nation's economic system evolved in an era of cheap energy and careless waste disposal, when limits seemed irrelevant. None of us today, whether we're managing a house or running a business, is living in a sustainable way. It's not a question of good guys and bad guys. There is no point in saying, If only those bad guys would go out of business, then the world would be fine. The whole system has to change; there's a huge opportunity for reinvention. We're entering a time of perhaps unprecedented discontinuity. Businesses grounded in the old model will became obsolete and die. At Monsanto, we're trying to invent some new businesses around the concept of environmental sustainability. We may not yet know exactly what those businesses will look like, but we're willing to place some bets because the world cannot avoid needing sustainability in the long run.

Unfortunately, Monsanto's name became inexorably intertwined with genetically-modified foods, also known as "Frankenfoods." The company's efforts to build a positive public image based on its diverse range of biotech products foundered for several reasons. One product, in particular, was symptomatic of Monsanto's imperfect strategy. "Terminator seeds," as they were called, were genetically-modified, sterile seeds sold to farmers that could not be used for more than one season, forcing farmers to return to Monsanto on an annual basis for new seed. On reflection, it is hard to imagine a product more antithetical to the concept of sustainability. The firestorm of criticism from the agricultural community was such that the company was forced to remove the product from the market. This was but one example of a series of misfortunes to befall Monsanto.

In 1999, the company was forced to merge with Pharmacia-Upjohn in an agreement which in many respects marked the demise of Robert Shapiro's pioneering vision. In a remarkable interview in November 2000 (http://www.monsanto.com/monsanto/layout/media/speeches/11-27-00.asp), the new CEO, Hendrik Verfaillie, outlined the nature of the mistakes made by Monsanto by ignoring its most important stakeholders – farmers, food retailers, consumers, environmental groups and the general public. To quote:

> We are making a new start as a company completely devoted to agriculture. . . .Monsanto had focused so much attention on getting the technology right for our customer —- the grower — that we didn't fully take into account the issues and concerns it raised for other people. . . .We thought we were doing some great things. A lot of other people thought we were making some mistakes. . . .We missed the fact that this technology raises major issues for people —- issues of ethics, of choice, of trust, even of democracy and globalization. . . .We did not understand that our tone — our very approach — was seen as arrogant. . . .We have developed a new pledge, to help us fulfill our promise for sustainable agriculture. This new Monsanto pledge includes the following five elements — dialogue, transparency, respect, sharing and delivering benefits.

Despite such setbacks, however, how successful have corporate initiatives been in general in the area of sustainable development? The record has been mixed, but on balance seems distinctly positive. One piece of evidence, in particular, demonstrates the value of creative thinking which incorporates sustainable development into top-level corporate strategy. The Social Investment Forum (www.socialinvest.org) includes fifty mutual funds which utilize environmental criteria in their choice of corporations listed. One of the most prominent initiatives is the Dow Jones Sustainability Group of Indexes. On its website (http://indexes.dowjones.com/djsgi/index/index.html), Dow Jones states that:

> The concept of corporate sustainability has long been very attractive to investors because of its aim to increase long-term shareholder value. Sustainability-driven companies achieve their business goals by integrating economic, environmental and social growth opportunities into their business strategies. These sustainability companies pursue these opportunities in a pro-active, cost-effective and responsible manner today, so that they will outpace their competitors and be tomorrow's winners.
>
> Sustainability companies not only manage the standard economic factors affecting their businesses but the environmental and social factors as well. There is mounting evidence that their financial performance is superior to that of companies that do not adequately, correctly and optimally manage these important factors.
>
> The superior performance is directly related to a company's commitment to the five corporate sustainability principles:
>
> • Technology: The creation, production and delivery of products and services should be based on innovative technology and organization that use financial, natural and social resources in an efficient, effective and economic manner over the long-term.
>
> • Governance: Corporate sustainability should be based on the highest standards of corporate governance including management responsibility, organizational capability, corporate culture and stakeholder relations.
>
> • Shareholders: The shareholders' demands should be met by sound financial returns, long-term economic growth, long-term productivity increases, sharpened global competitiveness and contributions to intellectual capital.
>
> • Industry: Sustainability companies should lead their industry's shift towards

sustainability by demonstrating their commitment and publicizing their superior performance.

• Society: Sustainability companies should encourage lasting social well being by their appropriate and timely responses to rapid social change, evolving demographics, migratory flows, shifting cultural patterns and the need for life-long learning and continuing education.

These principles are also the criteria by which sustainability companies can be identified and ranked for investment purposes. They facilitate a financial quantification of sustainability performance by focussing on a company's pursuit of sustainability opportunities — e.g., meeting market demand for sustainable products and services — and the reduction, ideally avoidance, of sustainability risks and costs. As a result, corporate sustainability is an investable concept. This relationship is crucial in driving interest and investments in sustainability to the mutual benefit of companies and investors. As this benefit circle strengthens, it will have a positive effect on the societies and economies of both the developed and developing world.

The track record of these financial indexes has been solid, as results have matched or outperformed the market since their inception. (See also, WBCSD, 1996; www.sam-group.com).

PART V: THE PROSPECTS

What are the prospects for achieving sustainability – economic, ecologic and social? On the face of it, the challenges seem monumental and potentially insurmountable. We live in a society which celebrates and thrives on economic growth and greets with dismay any news than such growth is waning. As Colman has stated (2002):

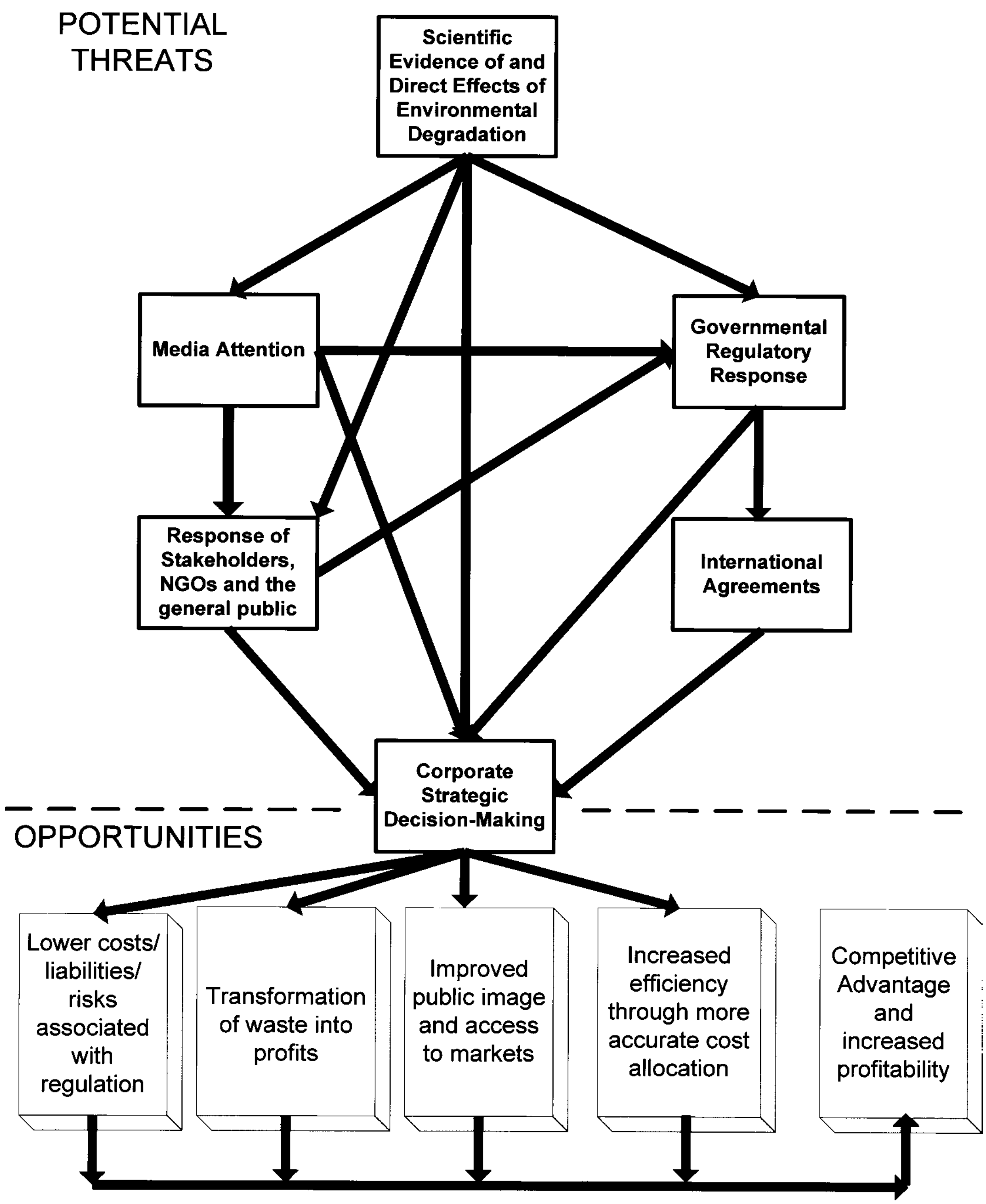
> The costs of holding on to the illusion that "more" is "better" are frightening. Scientists recognize that the only biological organism that has unlimited growth as its dogma is the cancer cell, the apparent model for our conventional economic theory. By contrast, the natural world thrives on balance and equilibrium, and recognizes inherent limits to growth. The cancer analogy is apt, because the path of limitless growth is profoundly self-destructive. No matter how many cars we have in the driveway or how many possessions we accumulate, the environment will not tolerate the growth illusion even if we fail to see through it.

Failing a radical change in our technology of production and the value system which underlies the "growth mentality," we must conclude that few business activities can be truly "sustainable" – only less unsustainable. But even a small shift from unsustainable practices would be a step in the right direction, allowing more time to tackle this immense problem. It is the nature of our market system that the total output of the economy is the result of the aggregation of numerous individual corporate and individual decisions. Those corporations which have recognized and profitably implemented sustainability concepts are still among the minority. There may, in fact, be fundamental limits to how many sectors are capable of restructuring for complete or partial sustainability. The benefits to the corporation from recognizing the strategic importance of sustainable development are still potentially significant. To quote Holliday et al. (2002, p.26)

A company stands to gain customer success, brand strength, first-mover advantage, motivated employees, and potentially more profits. The first step, however, is recognizing that both the political agenda and the business agenda are driving the move toward sustainability and its inherent opportunities.

As such, **Figure 1** which outlined the challenges from sustainable development facing the modern corporation is seriously incomplete and must be amended (as in **Figure 14**) to reflect more accurately the multifaceted environment in which the corporation finds itself. It is doubtless a world of

FIGURE 14



potential threats to business as usual; but it is also a dynamic environment which offers a broad range of opportunities to firms which have the strategic vision to recognize and capitalize on them.

So, what is the bottom line? Is global sustainability achievable in the near to midterm future? The answer is almost certainly no, given the convergence of continued population growth, the nature of current technology, the structure of industrial production, market-driven incentives which favour current consumption over investment, and prevailing social values and attitudes. None of these, however, precludes the necessity for individuals, governments and especially corporations from modifying their behaviour in a manner which moves us off, even incrementally, our current path of non-sustainability. Failure to do so will surely foreclose ecological options, accelerate environmental degradation, and increase the probability of our being faced with a serious and potentially irreversible ecological crisis which threatens the viability of the human endeavour and the planet on which we live.

The goal of achieving sustainable development is arguably the greatest challenge mankind has ever faced, requiring a concerted joint effort among consumers, business and government. It can be argued that if sustainable development is indeed to be achieved, then the *sine qua non* is the education of the emerging business elite in the fundamental principles of sustainable development, for only with the active engagement of the business community is there any realistic hope that our economic, social, and ecological systems can achieve sustainability.

FOOTNOTE

1. The 38 industrialized nations required to reduce their greenhouse gas emissions (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) under the Kyoto Accord are: Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, the United Kingdom, and the United States (UN, 1998).

ACKNOWLEDGEMENTS

The author would like to thank several anonymous reviewers as well as the following individuals for their advice and assistance in the preparation of this manuscript: Jean-Phillipe Barde**,** Head, National Policies Division, Environment Directorate, OECD; Ms. Linda Coady, Vice-President, Environment, Weyerhauser, Ltd.; Les Lavkulich, Director, Institute for Resources and Environment, University of British Columbia; and Fiona Danks, Scott Polar Research Institute, Cambridge University. The author remains responsible for any errors of omission or commission.

REFERENCES CITED

Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (1989) *Environmental Accounting for Sustainable Development*, UNEP-World Bank.

Anielski, Mark (2002) "GPI: Alberta's Sustainability Trends, 2000," in Nemetz, *Bringing Business on Board.*

Arctic Monitoring and Assessment Programme (AMAP) (1997) *Arctic Pollution Issues: A State of the Arctic Environment Report* (http://www.amap.no/assess/soaer-cn.htm)

Ayres, Robert U. and Leslie W. Ayres (1996) *Industrial Ecology. Towards Closing the Materials Cycle*, Edward Elgar.

Barde, Jean-Philippe (2002) “Green Tax Reforms in OECD Countries: An Overview,” in Nemetz, *Bringing Business on Board.*

Barnes, Kimberlee K. et al. (2002) “Water-Quality Data for Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S Streams, 1999-2000,” U.S. Geological Survey, Iowa City.

Bovard, James (1995) “Archer Daniels Midland: A Case Study in Corporate Welfare,” Case Policy Analysis No. 241, Cato Institute, September 26.

Brander, James and Scott Taylor (1998) “The Simple Economics of Easter Island: A Ricardo-Malthus Model of Renewable Resource Use, *American Economic Review,* Volume 88 (March), pp. 119-138.

Broecker, Wallace S. (1987) “Unpleasant Surprises in the Greenhouse?” *Nature*, July 9, pp. 123-126.

Canadian Manufacturers & Exporters (CME) (2002) *Pain Without Gain: Canada and the Kyoto Protocol*.

Carson, Rachel (1962) *Silent Spring*, Houghton Mifflin.

Centre for Environment and Sustainability (CES) (2002), “Technology and Policy for Sustainable Development,” Chalmers University of Technology and the Göteborg University, February 5.

Chambers et al. (1979) “Gasohol: Does It or Doesn’t It Produce Positive Net Energy?” *Science*, November 16, pp. 789-795.

Coady, Linda (2002) Vice-President, Environment, Weyerhauser Ltd., personal communication.

Colman, Ronald T. (2002) “Measuring Genuine Progress,” in Nemetz, *Bringing Business on Board.*

Congressional Budget Office (CBO) (1994) “Greening the National Accounts,” CBP Papers, March.

Costanza, Robert (ed.) *Ecological Economics: The Science and Management of Sustainability*, Columbia University Press.

Costanza, Robert et al. (1997a) “The Value of the World’s Ecosystem Services and Natural Capital,” *Nature*, Vol. 387, 15 May, pp. 253-260.

Costanza, Robert et al. (1997b) *An Introduction to Ecological Economics*, St. Lucie Press.

Costanza, Robert Cutler Cleveland, and Charles Perrings (2002) “The Development of Ecological Economics,” in Nemetz, *Bringing Business on Board*.

Daily, Gretchen (ed.) (1997) *Nature’s Services. Societal Dependence on Natural Ecosystems*, Island Press.

D’Arge, Ralph C., William D. Schulze and David S. Brookshire (1982) “Carbon Dioxide and Intergenerational Choice,” *American Economic Review*, May, pp. 251-256.

Daly, Herman E. (1999) *Ecological Economics and the Ecology of Economics*. Edward Elgar.

Daly, Herman E. and John B. Cobb, Jr. (1994) *For the Common Good*. Beacon Press.

Dayton, Paul K. et al. (2002) *Ecological Effects of Fishing in Marine Ecosystems of the United States*, Pew Oceans Commission.

Diamond, Jared (1995) “Easter’s End,” *Discover*, August, pp. 62-69.

Diamond, Jared (1999) *Guns, Germs and Steel. The Fates of Human Societies*, W.W. Norton & Company.

Den Elzen, M.G.J. and A.P.G. de Moor (2001) “The Bonn Agreement and Marrakesh Accords: an updated analysis," RIVM report 728001017/2001, prepared for the Dutch Ministry of Environment.

Denton, D. Keith (1994) *Enviro-Management. How Smart Companies Turn Environmental Costs into Profits*, Prentice Hall.

Desimone, Livio D. and Frank Popoff (1997) *Eco-efficiency. The Business Links to Sustainable Development*, The MIT Press.

Ditz, Daryl, Janet Ranganathan and R. Darryl Banks (1995) *Green Ledgers: Case Studies in Corporate Environmental Accounting*, World Resources Institute.

Dodds, Colin and Ronald T. Colman, (2002) "GPI: The Cost of Crime in Nova Scotia," in Nemetz, *Bringing Business on Board.*

Dorfman, Robert and Nancy S. Dorfman (eds.) (1993) *Economics of the Environment. Selected Readings*, Third Edition, W.W. Norton & Company.

Eisner, Robert (1994) *The Misunderstood Economy. What Counts and How to Count It*. Harvard Business School Press.

Ellerman, A. Denny et al. (2000) *Markets for Clean Air. The U.S. Acid Rain Program*. Cambridge University Press.

Environment Canada (2002) "Costs of Kyoto – What we Know," (http://www/ec.gc.ca/minster/speeches/2002/020318_t_e.htm)

Epstein, Paul R. et al. (1998) "Biological and Physical Signs of Climate Change: Focus on Mosquito-borne Diseases," *Bulletin of the American Meteorological Society*, Vol. 79, No. 3, March, pp.409-417.

European Environment Agency (EEA) (2001) "Internalisation of external costs," draft version 20-08-2001.

Fischer, Gunther, Mahendra Shah, Harrij van Velthuizen and Freddy O. Nachtergaele (2001) *Global Agro-ecological Assessment for Agriculture in the 21st Century*, IIASA.

Fussler, Claude and Peter James (1996) *Driving Eco-Innovation. A Breakthrough Discipline for Innovation and Sustainability*, Pitman Publishing.

Freund, Peter and George Martin (1993) *The Ecology of the Automobile*, Black Rose Books.

Gilliland, Martha W. (ed.) (1978) *Energy Analysis: A New Public Policy Tool*, Westview Press.

Globe and Mail (2002a) "Anderson says bill for Kyoto could top $10-billion," April 5, page A1.

Globe and Mail (2002b) "Kyoto impact estimates vary widely," April 26, page A7.

Goldenberg, Stanley B., Christopher W. Landsea, Alberto M. Mestas-Nunez, and William M. Gray (2001) "The Recent Increase in Atlantic Hurricane Activity: Causes and Implications, *Science*, Vol. 293, July 20, pp. 474-479.

Graedel, T.E. and B.R. Allenby (1995) *Industrial Ecology,* Prentice Hall.

Harvell, C. Drew et al. (2002) "Climate Warming and Disease Risks for Terrestrial and Marine Biota," *Science*, 21 June, Vol. 296, pp. 2158-2162.

Hawkin, Paul, Amory Lovins and Hunter Lovins (1999) *Natural Capitalism*: *Creating the Next Industrial Revolution*, Little Brown & Co.

Harremoes, Poul et al., (2002) *The Precautionary Principle in the 20th Century. Late Lessons From Early Warnings*. Earthscan.

Hillary, Ruth (ed.) (1997) *Environmental Management Systems and Cleaner Production*, John Wiley & Sons.

Hocking, Martin B. (1991) "Paper Versus Polystyrene: A Complex Choice," *Science,* February 1, pp. 504-5.

Hocking, Martin B. (1993) "Life Cycle Inventories: Uncoated Paper and Moulded Polystyrene Cups," in *B.C. Environment, Full Cost Accounting & the Environment*, Seminar Proceedings, March 19, Victoria, B.C., pp. 10-15.

Hogarth, Murray (2002) "Doing Sustainability: The Ecos Corporation Story," in Nemetz, *Bringing Business on Board*.

Holliday, Charles O., Stephan Schmidheiny and Philip Watts (2002) *Walking the Talk. The Business Case for Sustainable Development*. Greenleaf Publishing.

Holling, C.S. (1973) "Resilience and Stability of Ecological Systems," *Annual Review of Ecology and Systematics*, Volume 4, pp. 1-23.

Hopkinson, C.S. and J. W. Day Jr. (1980) "Net Energy Analysis of Alcohol Production from Sugarcane," *Science*, Vol. 207, (January 18) pp. 302-304.

Hunt, David and Catherine Johnson (1995) *Environmental Management Systems. Principles and Practice*, McGraw-Hill.

Institute for Energy Studies, Stanford University (IES) and TRW Systems Group (1975) *NSF-Stanford Workshop on Net Energy Analysis*, August 25-28.

Intergovernmental Panel on Climate Change (IPCC) (1996) *Climate Change 1995. Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses*. Cambridge University Press.

International Center for Technology Assessment (ICTA) (2000) *The Real Price of Gasoline*, Report No. 3.

International Council of Chemical Associations (ICCA) (2002) *ICCA Responsible Care Stats Report, 2002.*

International Joint Commission (IJC) (2000) *Tenth Annual Report*.

Inter-Organization Programme for the Sound Management of Chemicals (IOMC) (2002) *Reducing and Eliminating the Use of Persistent Organic Pesticides*, UNEP, Geneva.

Jackson, Jeremy B.C. et al. (2001) "Historical Overfishing and the Recent Collapse of Coastal Ecosystems," *Science,* Vol. 293, July 27, pp. 638.

Jansson, AnnMari et al. (1994) *Investing in Natural Capital. The Ecological Economics Approach to Sustainability*, Island Press.

Justus, John R. and Susan R. Fletcher (2001) "Global Climate Change," Congressional Research Service, The Library of Congress, June 22.

King, Andrew A, and Michael J. Lenox (2000) "Industry Self-Regulation Without Sanctions: The Chemical Industry's Responsible Care Program," *Academy of Management Journal*, Vol. 43, No. 4, pp. 698-716.

Koplin, Dana W. et al. (2002) "Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-200: A National Reconnaissance," *Environmental Science and Technology*, Vol. 36,No. 6, pp. 1202-1211.

Kuhre, W. Lee (1995) *ISO 14001. Environmental Management Systems*. Prentice-Hall.

Kuhre, W. Lee (1996) *ISO 14010s. Environmental Auditing*. Prentice-Hall.

Kuhre, W. Lee (1997) *ISO 14020s. Environmental Labelling-Marketing*. Prentice-Hall.

Kuhre, W. Lee (1998) *ISO 14031. Environmental Performance Evaluation (EPE)*. Prentice-Hall.

Lovins, Amory B., L. Hunter Lovins and Paul Hawken (2002) "A Road Map for Natural Capitalism, reprinted in Nemetz (ed.) *Bringing Business on Board*.

Lutz, Ernst (ed.) (1993) *Toward Improved Accounting for the Environment*, UNSTAT-World Bank.

MacKenzie, James J., Roger C. Dower and Donald D.T. Chen (1992) *The Going Rate: What it*

Really Costs to Drive, World Resources Institute.

Magretta, Joan (1997) "Growth Through Global Sustainability. An Interview with Monsanto's CEO, Robert B. Shapiro," *Harvard Business Review*, January-February, pp. 79-88.

Margolick, Michael and Doug Russell (2001) *Corporate Greenhouse Gas Reduction Targets*, Pew Center on Global Climate Change, Arlington, VA.

Matthews, Emily et al. (2000) *The Weight of Nations. Material Outflows from Industrial Economies*, World Resources Institute.

McCann, T.J. (2002) "Chemical Industry Integration," in Nemetz, *Bringing Business on Board*.

McDonough, William and Michael Braungart (2002) *Cradle to Cradle. Remaking the Way We Make Things*, North Point Press.

McInerney, Francis and Sean White (1995) *The Total Quality Corporation. How 10 Major Companies Added to Profits and Cleaned up the Environment in the 1990s,* Truman Talley Books/ Plume.

McLean, Brian (2002) "Implementing Emissions Trading: The U.S. Acid Rain Program and Ozone Transport Reduction Programs," in Nemetz, *Bringing Business on Board.*

McNeill, J.R. (2000) *Something New Under the Sun. An Environmental History of the Twentieth-Century World*, W.W. Norton & Company.

Miller, Peter and John Moffet (1993) *The Price of Mobility. Uncovering the Hidden Costs of Transportation*, Natural Resources Defense Council, October.

Miringoff, Marc and Marque-Luisa Miringoff (1999) *The Social Health of the Nation. How America Is Really Doing.* Oxford University Press.

National Research Council (NRC) (1999) *Ozone-Forming Potential of Reformulated Gasoline*, Commission on Geosciences, Environment and Resources, National Academy Press.

National Research Council (NRC) (2001) *Climate Change Science. An Analysis of Some Key Questions*, Committee on the Science of Climate Change, Division of Earth and Life Sciences, National Academy Press.

National Round Table on the Environment and the Economy (NRTEE) (1999) *Measuring Eco-efficiency in Business: Feasibility of a Core Set of Indicators.*

Nattrass, Brian and Mary Altomare (1999) *The Natural Step for Business. Wealth, Ecology and the Evolutionary Corporation,* New Society Publishers.

Nattrass, Brian and Mary Altomare (2002a) "IKEA: Nothing is Impossible," in Nemetz, *Bringing Business on Board.*

Nattrass, Brian and Mary Altomare (2002a) *Dancing With the Tiger. Learning Sustainability Step by Natural Step*, New Society Publishers.

Natural Resources Defense Council (NRDC) (2001) "China is Aggressively Reducing its Carbon Dioxide Emissions," www.nrdc.org/globalwarming/achinagg.asp.

Nemetz , Peter N. (ed.) (2002a) *Bringing Business on Board: Sustainable Development and the B-School Curriculum*, JBA Press, distributed by UBC Press, Vancouver, B.C.

Nemetz, Peter N. (2002b) "Waste to Profits: the Case of Consolidated Mining and Smelting Ltd.," in Nemetz, *Bringing Business on Board*.

New York Times (NYT) (1996) "It's Dwayne's World – Archer Daniel's Influence is Wide as Well as Deep," January 16.

New York Times (NYT) (2001) "178 Nations reach a climate Accord: U.S. only looks on," page A1, July 24.

Nordhaus, William D. and Edward C. Kiokkelenberg (eds.) (1999) *Nature's Numbers. Expanding*

the National Economic Accounts to Include the Environment, National Academy Press.
Nordic Council of Ministers (1992) *Product Life Cycle Assessment. Principles and Methodology.*
Oak Ridge National Laboratory (ORNL) (2000) "Global, Regional, and National CO_2 Emissions for Fossil Fuel Burning, Cement Production and Gas Flaring: 1751-1997," August. Website: http://cdiac.esd.ornl.gov/trends/emis_cont.052199.htm.
OECD (1999) *Voluntary Approaches for Environmental Policy. An Assessment*. Paris.
OECD (2000) *Greener Public Purchasing. Issues and Practical Solutions*. Paris.
OECD (2001a) *Environmentally Related Taxes in OECD Countries. Issues and Strategies.* Paris.
OECD (2001b) *Extended Producer Responsibility. A Guidance Manual for Governments*. Paris.
OECD (2001c) *Energy Balances of OECD Countries, 1998-1999*, Paris.
OECD (2001d) *Energy Balances of Non-OECD Countries*, *1998-1999*, Paris.
OECD (2002) Environmentally-related taxes database. (www.oecd.org/EN/document/0,,EN-document-471-14-no-1-3016-471,00.html.)
O'Riordan, Timothy (ed.) (1997) *Ecotaxation*. Earthscan.
Ottman, Jacquelyn A. (2002) "Interface Ltd.: One CEOs Environmental Odyssey," in Nemetz, *Bringing Business on Board*.
Pauly, Daniel (1999) "Global Fisheries and Marine Conservation: Is Co-existence Possible?" Address to The Vancouver Institute, November 6.
Pembina Institute and The David Suzuki Foundation (2001) *Climate-Friendly Hydrogen Fuel.*
Pezzey, John (1992) *Sustainable Development Concepts. An Economic Analysis*, World Bank, Environment Paper Number 2.
Ponting, Clive (1991) *A Green History of the World. The Environment and the Collapse of Great Civilizations.* Penguin Books.
Porter, Michael E. and Claas van der Linde (1995) "Green and Competitive: Ending the Stalemate," *Harvard Business Review*, Sep/Oct.
Redefining Progress (RP) (1999) *Why Bigger Isn't Better: The Genuine Progress Indicator – 1999 Update*, November.
Reed, Donald J. (2001) *Stalking the Elusive Business Case for Corporate Sustainability*, World Resources Institute, Washington, D.C.
Repetto, Robert et al. (1989) *Wasting Assets: Natural Resources in the National Income Accounts*, World Resources Institute, June.
Richter, Burton (2002) "Energy in the 21st Century," lecture at The Vancouver Institute, March 23, Vancouver, B.C.
Robbins, Peter Thayer (2001) *Greening the Corporation. Management Strategy and the Environmental Challenge*, Earthscan.
Robert, Karl-Henrik (2002) *The Natural Step. Seeding a Quiet Revolution*. New Society Publishers.
Rodenburg, Eric, Dan Tunstall and Frederik van Bolhuis (1995) *Environmental Indicators for Global Cooperation*, UNDP, UNEP and the World Bank, working paper number 11.
Romm, Joseph J. (1999) *Cool Companies. How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions*, Island Press.
Rosegrant, Mark W. et al. (2002) *Global Water Outlook to 2025. Averting an Impending Crisis*, International Food Policy Research Institute and International Water Management Institute.
Rubenstein, Daniel Blake (1994) *Environmental Accounting for the Sustainable Corporation. Strategies and Techniques*. Quorom Books.

Schaltegger, Stefan and Roger Burritt (2000) *Contempory Environmental Accounting. Issues, Concepts and Practice*. Greenleaf Publishing.

Schmidheiny, Stephan (1992) *Changing Course. A Global Business Perspective on Development and the Environment*, The MIT Press.

Serageldin, Ismail and Andrew Steer (eds.) (1993) *Valuing the Environment*, Proceedings of the First Annual International Conference on Environmentally Sustainable Development, The World Bank.

Settle, D.M. and C.C. Patterson (1980) "Lead in albacore: Guide to lead pollution in Americans," *Science*, Vol. 207, pp. 1167-1176.

Sharratt, Paul (ed.) (1995) *Environmental Management Systems*, Institute of Chemical Engineers.

Speer Lisa, et al. (1997) *Hook, Line and Sinking. The Crisis in Marine Fisheries*, Natural Resources Defense Council, February.

Stavins, Robert N. (ed.) (2000) *Economics of the Environment*. Selected Readings, Fourth Edition, W.W. Norton & Company.

Suzuki, David and Holly Dressel (2002) *Good News for a Change. Hope for a Troubled Planet.* Stoddard.

Tellus Institute and MR&GAssociates (2002) *The Bottom Line on Kyoto: Economic Benefits of Canadian Action*, prepared for the David Suzuki Foundation and World Wildlife Fund, Boston, MA.

Texas Transportation Institute (TTI) (2002) *2002 Urban Mobility Study*. (http://mobility.tamu.edu/mmp).

Tilman, David et al. (2001) "Forecasting Agriculturally Driven Global Environmental Change," *Science*, Vol. 292, April 13, pp. 281-284.

U.S. Council on Environmental Quality website (www.whitehouse.gov/ceq/)

U.S. Department of Agriculture (USDA) (1988) *Ethanol: Economic and Policy Tradeoffs.*

U.S. Department of State, (2002) *U.S. Climate Action Report 2002*, Washington, D.C., May.

U.S. Energy Information Administration (US EIA) (2001a) *International Energy Outlook 2001*, March.

U.S. Energy Information Administration (US EIA) (2001b) "International Energy-Related Information: Carbon Dioxide Emissions." Website: http://www.eia.gov/emeu/international/environm.html.

U.S. Environmental Protection Agency (EPA) (1994) *Germany, Garbage, and the Green Dot. Challenging the Throwaway Society*, September.

U.S. Environmental Protection Agency (EPA) (1995) "An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms."

U.S. Environmental Protection Agency (EPA) (2001) *Global Warming Site: Emissions Publications – 2001 National Inventory Tables* (http://www.epa.gov/globalwarming/publications/emissions/us20001/tables.html)

U.S. National Research Council (NRC-NAS) (2002) *Abrupt Climate Change. Inevitable Surprises.* National Academy Press.

U.S. President's Council on Sustainable Development (PCSD) (1999) *Towards a Sustainable America*, May.

U.S. Public Interest Research Group Education Fund (PIRG) (2001) *Flirting with Disaster. Global Warming and the Rising Costs of Extreme Weather*, Washington, D.C., April 17.

United Nations (UN) (1992) *Earth Summit. Agenda 21: The United Nations Programme of Action* *from Rio.*

United Nations (UN) (1993) *Integrated Environmental and Economic Accounting*.

United Nations (UN) (1998) "Framework Convention on Climate Change, Report of the Conference of the Parties On its Third Session, Held at Kyoto from 1 to 11 December," Addendum, Part Two: Action Taken by the Conference of the Parties at its Third Session.

United Nations Environment Programme (UNEP) (1999) *Global Environment Outlook,* Earthscan.

United Nations Environment Programme (UNEP) (2002) *Global Environment Outlook 3.*

United Nations Environment Programme (UNEP), U.S. NASA, U.S. Geological Survey and U.S. Forest Service (2001) *An Assessment of the Status of the World's Remaining Closed Forests,* August.

Van Dieren, Wouter (ed.) (1995) *Taking Nature Into Account*. A Report to the Club of Rome, Copernicus.

Wackernagel, Mathis et al. (1997) "Ecological Footprints of Nations," March 10.

Wackernagel, Mathis et al. (2001) "Ecological Footprints of Nations. How Much Nature Do They Use? How Much Nature Do They Have?" http://www.ecouncil.ac.cr/rio/focus/report/english/footprint.

Wackernagel, Mathis and William Rees (1996) *Our Ecological Footprint. Reducing Human Impact on the Earth*, New Society Publishers.

Ward's Communications (2000) *Motor Vehicle Facts & Figures, 2000*.

Ward's Communications (2001a) *Motor Vehicle Facts & Figures, 2001*.

Ward's Communications (2001b) *World Motor Vehicle Data, 2000 edition*.

Werth, David and Roni Avissar (2002) "The local and global effects of Amazon deforestation," *Journal of Geophysical Research*, Vol. 107 (preprint).

Wigley, T.M.L. and S.C.B. Raper (2001) "Interpretation of High Projections for Global-Mean Warming," *Science*, Vol. 293, July 20, pp. 451-454.

Winstanley, Gil, Brian Emmett, Bert McInnis, Brenda Siegel and Murray Randall (1977) *Energy Requirements Associated With Selected Canadian Energy Developments*, Office of Energy Conservation, Energy, Mines and Resources Canada.

World Business Council for Sustainable Development (WBCSD) (1996) *Environmental Performance and Shareholder Value.*

World Business Council for Sustainable Development (2000a) *Eco-efficiency: Creating more value with less impact.*

World Business Council for Sustainable Development (2000b) *Measuring Eco-efficiency: A guide to reporting company performance.*

World Commission on Environment and Development (WCED) (1987) *Our Common Future*. Oxford University Press.

World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) (2001) *Climate Change 2001. Synthesis Report*, Cambridge University Press.

World Resources Institute (WRI), United Nations Development Programme, United Nations Environment Programme, World Bank (2000) *World Resources 2000-2001. People and Ecosystems. The Fraying Web of Life.* Elsevier Science.

World Wildlife Fund WWF, UNEP, Redefining Progress, Center for Sustainability Studies (2000) *Living Planet Report 2000*.

World Wildlife Fund WWF, UNEP, Redefining Progress, Center for Sustainability Studies (2002) *Living Planet Report 2002*.

Young, Rebekah, Susana Hurtado Baker and Frederico Ortiz Lopez (2002) "Byproduct Synergy: Mexico," in Nemetz, *Bringing Business on Board*.

OTHER USEFUL REFERENCES ON BUSINESS AND SUSTAINABLE DEVELOPMENT

Aldrich, James R. (1996) *Pollution Prevention Economics: Financial Impacts on Business and Industry*, McGraw-Hill.

Arnold, Matthew B. and Robert M. Day (1998) *The next bottom line: making sustainable development tangible,* World Resources Institute.

Association of Chartered Certified Accountants (ACCA) and United Nations Environment Programme (2002) *Industry as a Partner for Sustainable Development: Accounting*, London.

Bansal, Pratima and Elizabeth Howard (eds.) (1997) *Business and the Natural Environment*, Butterworth Heinemann.

Baumert, Kevin A. et al. (2002) *Options for Protecting the Climate. Building on the Kyoto Protocol*, World Resources Institute, October.

Bennett, Martin and Peter James (eds.) (1998) *The Green Bottom Line. Environmental Accounting for Management*, Greenleaf Publishing.

Boustie, Sylvie et al. (2002) *How Ratifying the Kyoto Protocol Will Benefit Canada's Competitiveness,* Pembina Institute, June.

Bramley, Matthew (2000) *Greenhouse Emissions from Industrial Companies in Canada: 1998*, October.

Bramley, Matthew (2002) *The Case for Kyoto: The Failure of Voluntary Corporate Action*, Pembina Institute, October.

Brown, Lester R. (2001) *Eco-Economy. Building an Economy for the Earth*. W.W. Norton & Company.

Buchholz, Rogene A. (1993) *Principles of Environmental Management: the Greening of Business*, Prentice-Hall.

Buchholz, Rogene A. et al. (1992) *Managing Environmental Issues: A Casebook*, Prentice-Hall.

Cairncross, Frances (1995) *Green, Inc. A Guide to Business and the Environment*, Island Press.

Cairncross, Francis (1992) *Costing the Earth: The Challenge for Governments, the Opportunities for Business*, Harvard Business School Press.

Canada (2002) *Climate Change Plan for Canada*, November 21.

Canada, Tradeable Permits Working Group (2000) *Using Tradeable Emissions Permits To Help Achieve Domestic Greenhouse Gas Objectives. Options Report*, National Climate Change Process, April.

Ciambrone, David F. (1996) *Waste Minimization as a Strategic Weapon*, CRC Lewis Publishers.

Clark, William C. et al. (2002) *The State of the Nation's Ecosystems, Measuring the Lands, Waters, and Living Resources of the United States*, The H. John Heinz III Centre for Science, Economics and the Environment.

Coddington, Walter (1993) *Environmental Marketing. Positive Strategies for Reaching the Green Consumer*, McGraw-Hill.

Crosbie, Liz and Ken Knight (1995) *Strategy for Sustainable Business. Environmental Opportunity and Strategic Choice*, McGraw-Hill.

Daily, Gretchen and Katherine Ellison (2002) *The New Economy of Nature. The Quest to Make Conservation Profitable*, Island Press.

Ditz, Daryl and Janet Ranganathan (1997) *Measuring Up. Toward a Common framework for tracking environmental performance*, World Resources Institute, July.

Durnil, Gordon K. (1995) *The Making of a Conservative Environmentalist*, Indiana University Press.

Elkington, John (1998) *Cannibals with Forks. The Triple Bottom Line of 21st Century Business,* New Society Publishers.

Fischer, Kurt and Johan Schot (eds.) (1993) *Environmental Strategies for Industry*, Island Press.

Harvard Business Review (2000) *On Business and the Environment*, Harvard Business School Press.

Hawken, Paul (1993) *The Ecology of Commerce,* HarperBusiness.

Hoffert, Martin I. et al. (2002) "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet," *Science*, Vol. 298, 1 November, pp. 981-987.

Ibbotson, Brett and John-David Phyper (1996) *Environmental Management in Canada*, McGraw-Hill Ryerson.

International Institute for Sustainable Development (IISD),Deloitte & Touche, and Business Council for Sustainable Development (n.d.) *Business Strategy for Sustainable Development. Leadership and Accountability for the '90s*.

Jacobs, Michael (1993) *The Green Economy. Environment, Sustainable Development and the Politics of the Future*, UBC Press.

Kinlaw, Dennis C. (1993) *Competitive and Green. Sustainable Performance in the Environmental Age*, Pfeiffer & Co.

Makower, Joel (1994) *The E-Factor. The Bottom-Line Approach to Environmentally Responsible Business*, Tilden Press.

Martinez-Alier, Juan (1987) *Ecological Economics. Energy, Environment and Society*. Basil Blackwell.

Milani, Brian (2000) *Designing the Green Economy. The Postindustrial Alternative to Corporate Globalization*, Rowman & Littlefield.

Miller, Gord (2002) *Climate Change: Is the Science Sound?* Special Report to the Legislative Assembly of Ontario, Environmental Commissioner of Ontario, November 19.

North, Klaus (1997) *Environmental Business Management. An Introduction*. 2nd edition, ILO.

OECD (2002a) *Implementing Domestic Tradeable Permits. Recent Developments and Future Challenges, Paris*.

OECD (2002b) *Working Together Towards Sustainable Development. The OECD Experience,* Paris.

Olsen, Ken et al. (2002) *Canada's Greenhouse Gas Inventory, 1990-2000*, Environment Canada, Greenhouse Gas Division, June.

O'Riordan, Timothy and Heather Voisey (eds.) *Agenda 21. The Transition to Sustainability. The Politics of Agenda 21 in Europe*, Earthscan.

Pearce, David and Edward B. Barbier (2000) *Blueprint for a Sustainable Economy*, Earthscan.

Piasecki, Bruce W. (1995) *Corporate Environmental Strategy. The Avalanche of Change Since Bhopal*, John Wiley & Sons.

Piasecki, Bruce W., Kevin A. Fletcher and Frank J. Mendelson (1999) *Environmental Management and Business Strategy. Leadership Skills for the 21st Century*, John Wiley & Sons.

Romm, Joseph J. (1994) *Lean and Clean Management. How to Boost Profits and Productivity by Reducing Pollution*, Kodansha International.

Seemer, Stephen W. (ed.) (1996) *Environmental ROI. Successful Techniques in Cost Avoidance*, John Wiley & Sons.

Shrivastava, Paul (1996) *Greening Business. Profiting the Corporation and the Environment*, Thomson Executive Press.

Smart, Bruce (1992) *Beyond Compliance: A New Industry View of the Environment*, World Resources Institute, April.

Smith, Denis (ed.) (1993) *Business and the Environment. Implications of the New Environmentalism*, Palgrave.

Torrie, Ralph et al. (2002) *Kyoto and Beyond. The Low Emission Path to Innovation and Efficiency.* David Suzuki Foundation and the Canadian Climate Action Network.

U.S. Energy Information Administration (1999) Annual Energy Review 1998 (http://www.eia.doe.gov)

U.S. Energy Information Administration (2000) *International Energy Outlook 2000*, March (http://www.eia.doe.gov)

Von Weizsacker, Ernst, Amory B. Lovins and L. Hunter Lovins (1997) *Factor Four. Doubling Wealth, Halving Resource Use*. Earthscan.

Wackernagel, Mathis et al. (2002) "Tracking the ecological overshoot of the human economy," (www.pnas.org/cgi/doi/10.1073/pnes.142033699)

Welford, Richard (1997) *Corporate Environmental Management 2: Culture and Organizations*, Earthscan.

World Bank (2003) *Sustainable Development in a Dynamic World. Transforming Institutions, Growth, and Quality of Life, World Development Report 2003*, Oxford University Press.

ANNEX A: Major International Agreements Relating to the Environment and Development

Source: Yearbook of International Co-operation on Environment and Development (http://www.greenyearbook.org)

General environmental concerns

- Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Århus Convention), Århus, 1998
- Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), Espoo, 1991

Atmosphere

- Annex 16, vol. II (Environmental Protection: Aircraft Engine Emissions) to the 1944 Chicago Convention on International Civil Aviation, Montreal, 1981
- Convention on Long-Range Transboundary Air Pollution (LRTAP), Geneva, 1979
- Framework Convention on Climate Change (UNFCCC), New York, 1992
- Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985, including the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987

Hazardous Substances

- Convention on the Ban of the Import into Africa and the Control of Transboundary Movements and Management of Hazardous Wastes within Africa, Bamako, 1991
- Convention on Civil Liability for Damage Caused during Carriage of Dangerous Goods by Road, Rail, and Inland Navigation Vessels (CRTD), Geneva, 1989
- Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention), Basel, 1989
- Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention on PIC), Rotterdam, 1998
- Convention on the Transboundary Effects of Industrial Accidents, Helsinki, 1992
- Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region (Waigani Convention), Waigani, 1995
- European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN), Geneva, 2000
- European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR), Geneva, 1957
- FAO International Code of Conduct on the Distribution and Use of Pesticides, Rome, 1985
- Stockholm Convention on Persistent Organic Pollutants, (Stockholm Convention on POPs), Stockholm, 2001

Marine Environment - Global Conventions

- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention 1972), London, 1972
- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), London, 1973 and 1978
- International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001, (Bunkers Convention), London, 2001
- International Convention on Civil Liability for Oil Pollution Damage 1969 (1969 CLC), Brussels, 1969, 1976, and 1984
- International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971 (1971 Fund Convention), Brussels, 1971
- International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNS), London, 1996
- International Convention on Oil Pollution Preparedness, Response, and Co-operation (OPRC), London, 1990
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Intervention Convention), Brussels, 1969
- United Nations Convention on the Law of the Sea (LOS Convention), Montego Bay, 1982

Marine Environment - Regional Conventions

- Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), Paris, 1992
- Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992 Helsinki Convention), Helsinki, 1992
- Conventions within the UNEP Regional Seas Programme:
- Convention on the Protection of the Black Sea against Pollution, Bucharest, 1992
- Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, Cartagena de Indias, 1983
- Convention for the Protection, Management, and Development of the Marine and Coastal Environment of the Eastern African Region, Nairobi, 1985
- Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution, Kuwait, 1978
- Convention for the Protection and Development of the Marine Environment and Coastal Region of the Mediterranean Sea (Barcelona Convention), Barcelona, 1976
- Regional Convention for the Conservation of the Red Sea and the Gulf of Aden Environment, Jeddah, 1982
- Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, Noumea, 1986
- Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific, Lima, 1981
- Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, Abidjan, 1981

Marine Living Resources

- Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), Canberra, 1980
- International Convention for the Conservation of Atlantic Tunas (ICCAT), Rio de Janeiro, 1966
- International Convention for the Regulation of Whaling (ICRW), Washington, 1946

Nature Conservation and Terrestrial Living Resources

- Antarctic Treaty, Washington, DC, 1959
- Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention), Paris, 1972
- Convention on Biological Diversity (CBD), Nairobi,1992
- Convention on the Conservation of Migratory Species of Wild Animals (CMS), Bonn, 1979
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington, DC, 1973
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), Ramsar, 1971
- Convention to Combat Desertification (CCD), Paris,1994
- FAO International Undertaking on Plant Genetic Resources, Rome, 1983
- International Tropical Timber Agreement, 1994 (ITTA,1994), Geneva, 1994

Nuclear Safety

- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention), Vienna, 1986
- Convention on Early Notification of a Nuclear Accident (Notification Convention), Vienna, 1986
- Convention on Nuclear Safety, Vienna, 1994
- Vienna Convention on Civil Liability for Nuclear Damage, Vienna, 1963

Freshwater Resources

- Convention on the Protection and Use of Transboundary Watercourses and International Lakes (ECE Water Convention), Helsinki, 1992