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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Clean business: policy, practice and economic implications

By P. Ekins

Environmental Policy Unit, Department of Economics, Keele University, Staffordshire ST5 5BG, UK

Business has a substantial part to play in addressing the contemporary environmental challenge. This paper presents a model of wealth creation that can be applied to individual businesses or the economy as a whole, in order to understand the role of the environment in wealth creation and how this may cause its deterioration. From this model it is possible to derive principles and standards for environmental sustainability for the economy, from which a definition of a clean business is derived. To reduce its environmental impacts, a business needs to adopt new environmental reporting and accounting systems, which are discussed, together with evidence that such systems can enhance a firm's productivity and competitiveness. Government interventions, including the use of environmental taxes and charges, will be required for businesses generally to become cleaner, but the paper concludes that the leading companies that successfully become clean businesses ahead of legislative requirements may well save costs and gain competitive advantage from so doing.

1. Introduction

The purpose of a business is to create wealth. This is sometimes interpreted as increasing the value of shareholdings. However, such private accumulation is only justifiable from a wider social perspective if it proceeds having taken account of, and internalized into its structure of costs and prices, any social and environmental impacts resulting from the business activity.

It is widely perceived that business as a whole is generating environmental costs which are not reflected in market prices and which are therefore a source of economic inefficiency, resulting in a loss of human welfare. Thus the Brundtland Report of the World Commission of Environment and Development (WCED 1987), in its chapter on industry stated that 'It is evident that measures to reduce, control and prevent industrial pollution will need to be greatly strengthened. If they are not, pollution damage to human health could become intolerable in certain cities and threats to prosperity will continue to grow ... If sustainable development is to be sustainable over the long term, it will have to change radically in terms of the quality of that development.' (WCED 1987, pp. 211, 213).

In its Fifth Environmental Action Programme, the European Commission identified five sectors as being environmentally problematic: energy, agriculture, transport, industry and tourism. It said bluntly that 'Virtually all enterprises use natural resources for their processes and products, create various types of waste, and contribute to the pollution of air, water and soil. In limited cases only have the long term costs of

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these resources and of the pollution so far been internalized in the costs of operating a plant or in the price of the final product or service. It is clear that the perpetuation of this situation is not viable on either economic or environmental grounds.' (EC 1992, p. 27). OECD environmental data identify the same target sectors as the most important sources of environmental pressure (OECD 1995*a*).

There is now impressive consensus that the scale and intensity of the environmental challenge are such as to make business as usual—small variations within a largely unchanged context of policy and practice—a response that is both inadequate and potentially disastrous. Thus the World Resources Institute (WRI), in collaboration with both the Development and Environment Programmes of the United Nations, concludes on the basis of one of the world's most extensive environmental databases that 'The world is not now headed toward a sustainable future, but rather toward a variety of potential human and environmental disasters.' (WRI 1992 p. 2).

In its annual State of the World reports, the Worldwatch Institute has documented current environmental damage, concluding in 1993 that 'The environmentally destructive activities of recent decades are now showing up in reduced productivity of croplands, forests, grasslands and fisheries; in the mounting cleanup costs of toxic waste sites; in rising health care costs for cancer, birth defects, allergies, emphysema, asthma and other respiratory diseases; and in the spread of hunger.' (Brown *et al.* 1993, pp. 4–5). These trends mean that 'If we fail to convert our self-destructing economy into one that is environmentally sustainable, future generations will be overwhelmed by environmental degradation and social disintegration.' (Brown *et al.* 1993, p. 21). The Royal Society itself, in an unprecedented joint statement with the US National Academy of Sciences, concluded in its message to the 1992 Rio Summit that 'Unrestrained resource consumption for energy production and other uses . . . could lead to catastrophic outcomes for the global environment. Some of the environmental changes may produce irreversible damage to the Earth's capacity to sustain life . . . The future of our planet is in the balance.' (RS & NAS 1992, pp. 2, 4).

An important, indeed indispensable, condition for meeting this environmental challenge successfully is the transformation of the way goods and services are produced; a transformation of business into 'clean business'. The Brundtland Report broadly characterized this transformation as the development of industries and industrial operations 'that are more efficient in terms of resource use, that generate less pollution and waste, that are based on the use of renewable rather than non-renewable resources and that minimize irreversible adverse impacts on human health and the environment' (WCED 1987, p. 213). This paper will develop some ideas as to how business can, and how far business should, move in this direction. The paper starts by presenting a model of wealth creation, equally applicable to a business or the macroeconomy, in order to understand the range of contributions made by the environment to business activity and the economy (§ 2). It then places this contribution in the context of the emerging concept of environmental sustainability, which is becoming a major organizing principle of environmental policy (§ 3). Section 4 considers how businesses are starting to monitor, measure, report and account for their environmental impacts, a necessary precondition to being able to manage them. Section 5 discusses the extent to which it is financially feasible, in the current business context, for businesses to move towards environmental sustainability, and presents the results of some case studies which suggest that substantial progress is, in fact, possible. Section 6 then sets out some of the changes that need to be made to the current business context to encourage more businesses down this route, by ensuring that

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it is environmentally sustainable businesses that are the most profitable. Section 7 concludes.

The transformation of industrial production into 'clean business', a process which is sometimes called 'ecological modernization', will not be easy. As the Business Council for Sustainable Development noted: 'The requirement for clean, equitable, economic growth remains the single biggest difficulty with the larger challenge of sustainable development. Proving that such growth is possible is certainly the greatest test for business and industry.' (Schmidheiny 1992, p. 9). This paper suggests how the test might be approached in a way that makes the most of the opportunities that are offered, as well as pointing out the problems.

2. Understanding wealth creation

The process of wealth creation is most commonly characterized as one in which different kinds of asset, or capital, are brought together in production to produce goods and services. It is evident from any consideration of real-life production that one of the most fundamental stocks of capital is that provided by nature, here called ecological or natural capital. It is the role of this kind of capital that is emphasized in the model that follows, so that the natural environment's role in and contribution to business activity and the economy may be better understood.

Figure 1 portrays four kinds of capital stock: ecological (or natural) capital, human capital, social and organizational capital and manufactured capital. Each of these stocks produces a flow of 'services' from the environment (E), from human capital (L), from social/organizational capital (S) and from physical capital (K), services which serve as inputs into the productive process, along with 'intermediate inputs' (M) which are previous outputs from the economy which are used as inputs in a subsequent process.

Manufactured capital comprises material goods—tools, machines, buildings, infrastructure—which contribute to the production process but do not become embodied in the output and, usually, are 'consumed' in a period of time longer than a year. Intermediate goods, in contrast, either are embodied in produced goods (e.g. metals, plastics, components) or are immediately consumed in the production process (e.g. fuels). Human capital comprises all individuals' capacities for work; while social and organizational capital comprises the networks and organizations through which the contributions of individuals are mobilized and coordinated.

Ecological capital is a complex category which performs three distinct types of environmental function (Pearce & Turner 1990, pp. 35 ff.), two of which are directly relevant to the production process. The first is the provision of resources for production (E), the raw materials that become food, fuels, metals, timber, etc. The second is the absorption of wastes (W) from production, both from the production process and from the disposal of consumption goods. Where these wastes add to or improve the stock of ecological capital (e.g. through recycling or fertilization of soil by livestock), they can be regarded as investment in such capital. More frequently, where they destroy, pollute or erode, with consequent negative impacts on the ecological, human or manufactured capital stocks, they can be regarded as agents of negative investment, depreciation or capital consumption. Either way, the wastes contribute to the capital feedback effects identified in figure 1.

The third type of environmental function does not contribute directly to production, but in many ways it is the most important type because it provides the basic

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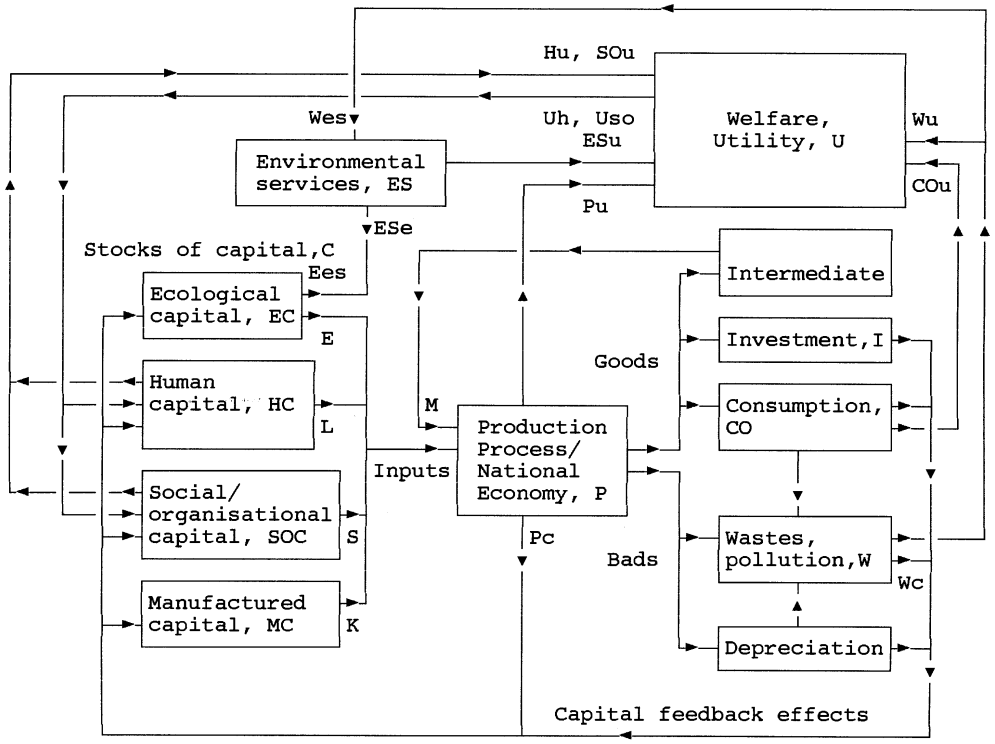

Figure 1. Stocks, flows and welfare in the process of production. Note: in the flow descriptors, the upper-case letters denote the source of the flow, lower-case letters denote the destination.

Stocks of capital, C		*Flows from the capital stock*
EC	ecological capital	E, (resources) from EC
HC	human capital	L, (labour) from HC
SOC	social/organizational capital	S, from SOC
MC	manufactured capital	K, from MC

Other flows

Ees	flows of environmental services from EC
ESe	effects of environmental services (e.g. climate) on EC
M	flows of intermediate goods into the production process, P
Pc	effects of P on the various components of the capital stock, C
Wc	effects of wastes (pollution) on C
Pu	effects of P on welfare, U
Wu	effects of pollution on U
Wes	effects of pollution on environmental services, ES
ESu	effects of environmental services, ES, on U
COu	effects of consumption, CO, on U
Hu, SOu	effects of human and social/organizational capital on U
Uh, Uso	effects of welfare, U, on human and social/organizational capital

context and conditions within which production is possible at all. It comprises basic 'environmental services' (ES), including 'survival services' such as those producing climate and ecosystem stability, shielding of ultraviolet radiation by the ozone layer and 'amenity services' such as the beauty of wilderness and other natural areas. These services are produced directly by ecological capital independently of human activity, but human activity can certainly have an (often negative) effect on the re-

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sponsible capital and therefore on the services produced by it, through the capital feedback effects discussed earlier.

The outputs of the economic process can, in the first instance, be categorized as 'goods' and 'bads'. The goods are the desired outputs of the process, as well as any positive externalities (incidental effects) that may be associated with it. These goods can be divided in turn into consumption, investment and intermediate goods and services. The bads are the negative effects of the production process, including capital depreciation and polluting wastes and other negative externalities, which contribute to environmental destruction, negative effects on human health, etc. Insofar as they have an effect on the capital stocks, the bads can be regarded as negative investment.

The necessity for a matter–energy balance on either side of the production process means that all matter and energy that feature as inputs must also emerge as outputs, either embodied in the goods or among the bads. On disposal of the former, therefore, all these former inputs are returned to the environment, to the stock of ecological capital, where they may have a positive, negative or neutral effect.

Human welfare, or utility as economists call it, is generated at many points of the overall process of wealth creation. It is derived from consumption (COu); it can be generated through work satisfaction (Pu); it is derived from social and organizational structures (SOu); it is a function of human capital itself (Hu); and, most importantly for this paper, it is affected by the quality of the natural environment (ESu) and by the nature and level of wastes (Wu),

Wastes and pollution from the production process and consumption affect utility directly (Wu, e.g. litter, noise) and through their mainly negative feedback into the stocks of environmental, human and manufactured capital. These feedbacks (Wc) can reduce the productivity of environmental resources (e.g. through pollution) and affect the ecological capital that produces environmental services (e.g. by engendering climate change or damaging the ozone layer); they can damage human capital by engendering ill health; and they can corrode buildings (manufactured capital). They can also affect environmental services directly (Wes, e.g. by reducing the appreciation of natural beauty).

Figure 1 emphasizes feedback effects. One that has not yet been mentioned is the joint relationship between the stock of ecological capital (EC) and the environmental services (ES) deriving from it. In a stable ecosystem, EC and ES will tend to be symbiotically balanced.

Through this model it is possible more clearly to characterize the environmental characteristics of a 'clean business'. First, however, it is necessary briefly to explore the concept that is becoming the organizing principle of much environmental policy, that of environmental sustainability.

3. Business and environmental sustainability

The basic meaning of sustainability is the capacity for continuance more or less indefinitely into the future. As discussed in the introduction, it is now clear that, in aggregate, current human ways of life do not possess that capacity, either because they are destroying the environmental conditions necessary for their continuance, or because their environmental effects will cause unacceptable social disruption and damage to human health. The environmental effects in question include climate change, ozone depletion, acidification, toxic pollution, the depletion of renewable

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resources (e.g. forests, soils, fisheries, water) and of non-renewable resources (e.g. fossil fuels) and the extinction of species.

A way of life is a complex bundle of values, objectives, institutions and activities, with ethical, environmental, economic and social dimensions. While current concern about unsustainability largely has an ecological basis, it is clear that human situations or ways of life can be unsustainable for social and economic reasons as well. The pertinent questions are: for the environment, can its contribution to human welfare and to the human economy be sustained? for the economy, can today's level of wealth creation be sustained? and for society, can social cohesion and important social institutions be sustained? In what follows the focus is on the environmental–economic dimensions of sustainability.

Economic sustainability is most commonly interpreted as a condition of non-declining economic welfare projected into the future. As has been seen, economic welfare derives from, *inter alia*, income and from the environment, which performs various functions, some of which contribute to production, and therefore income, others of which contribute to welfare directly. Income is generated by stocks of capital, including manufactured, human and natural capital. Natural capital also performs the welfare-creating environmental functions. Non-declining economic welfare requires, *ceteris paribus*, that the stock of capital be maintained (Pezzey 1992, pp. 14 ff.).

There is then the issue as to whether it is the total stock of capital that must be maintained, with substitution allowed between various parts of it, or whether certain components of capital, particularly natural capital, are non-substitutable, i.e. they contribute to welfare in a unique way that cannot be replicated by another capital component. 'Weak' environmental sustainability conditions derive from a perception that welfare is not normally dependent on a specific form of capital and can be maintained by substituting manufactured for natural capital. 'Strong' sustainability conditions derive from a different perception that substitutability of manufactured for natural capital is seriously limited by such environmental characteristics as irreversibility, uncertainty and the existence of 'critical' components of natural capital, which make a unique contribution to welfare (Pearce & Atkinson 1992; Turner 1992). An even greater importance is placed on natural capital by those who regard it in many instances as a complement to man-made capital (Daly 1992, pp. 27 ff.).

To some extent, it is possible to view the process of industrialization as the application of human and social capital to natural capital to transform it into human-made capital. But it is now clear that such substitutability is not complete. If our current development is unsustainable, it is because it is depleting some critical, non-substitutable components of the capital base on which it depends. It is to safeguard such critical natural capital that conditions such as the following need to be applied if the environment is to be used sustainably.

(1) Destabilization of global environmental features such as climate patterns or the ozone layer must be prevented. Most important in this category are the maintenance of biodiversity (see condition 2), the prevention of climate change, by the stabilization of the atmospheric concentration of greenhouse gases, and safeguarding the ozone layer by ceasing the emission of ozone-depleting substances.

(2) Important ecosystems and ecological features must be absolutely protected to maintain biological diversity. Importance in this context comes from a recognition not only of the perhaps as yet unappreciated use value of individual species, but also of the fact that biodiversity underpins the productivity and resilience of ecosystems.

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(3) The renewal of renewable resources must be fostered through the maintenance of soil fertility, hydrobiological cycles and necessary vegetative cover and the rigorous enforcement of sustainable harvesting. The latter implies basing harvesting rates on the most conservative estimates of stock levels, for such resources as fish; ensuring that replanting becomes an essential part of such activities as forestry; and using technologies for cultivation and harvest that do not degrade the relevant ecosytem and deplete neither the soil nor genetic diversity.

(4) Depletion of non-renewable resources should seek to balance the maintenance of a minimum life expectancy of the resource with the development of substitutes for it. On reaching the minimum life expectancy, its maintenance would mean that consumption of the resource would have to be matched by new discoveries of it. To help finance research for alternatives and the eventual transition to renewable substitutes, all depletion of non-renewable resources should entail a contribution to a capital fund. Designing for resource efficiency and durability can ensure that the practice of repair, reconditioning, reuse and recycling (the 'four R's') approach the limits of their environmental efficiency.

(5) Emissions into air, soil and water must not exceed their critical load, that is, the capability of the receiving media to disperse, absorb, neutralize and recycle them, nor may they lead to life-damaging concentrations of toxins. Synergies between pollutants can make critical loads very much more difficult to determine. Such uncertainties should result in a precautionary approach in the adoption of safe minimum standards.

(6) Landscapes of special human or ecological significance, because of their rarity, aesthetic quality or cultural or spiritual associations, should be preserved.

(7) Risks of life-damaging events from human activity must be kept at very low levels. Technologies, which threaten long-lasting ecosystem damage at whatever level of risk, should be foregone.

It is clear that these are aggregate conditions and that comparable conditions for individual businesses cannot simply be derived from them. However, they do establish a context within which the characteristics of a 'clean business' can be defined: a business is clean if its emissions to air, soil and water are both well within local thresholds of ecosystem and human vulnerability and do not make a disproportionate contribution to aggregate emissions, where these have an effect beyond the local scale; if it does not deplete the stock of resources which feeds into its production process, either because its resources are renewable and are being renewed, or because it is increasing the efficiency of its non-renewable resource use at a greater rate than the decline of the resource stock; and if its products and processes do not entail risks, even at a very low level, of large-scale or irreversible negative impacts on people or the environment.

Such concerns fall well outside traditional systems of business management. Before they can begin to be addressed by companies, companies must measure and monitor their environmental performance as carefully as they do any other core business outcome.

4. Measuring corporate environmental performance

From an environmental point of view, what matters with regard to business activity is its contribution to depletion and pollution, which is related in turn to the nature and volume of its inputs of energy and other natural resources, its emissions to air, water and land, the use of energy and materials by its products during their

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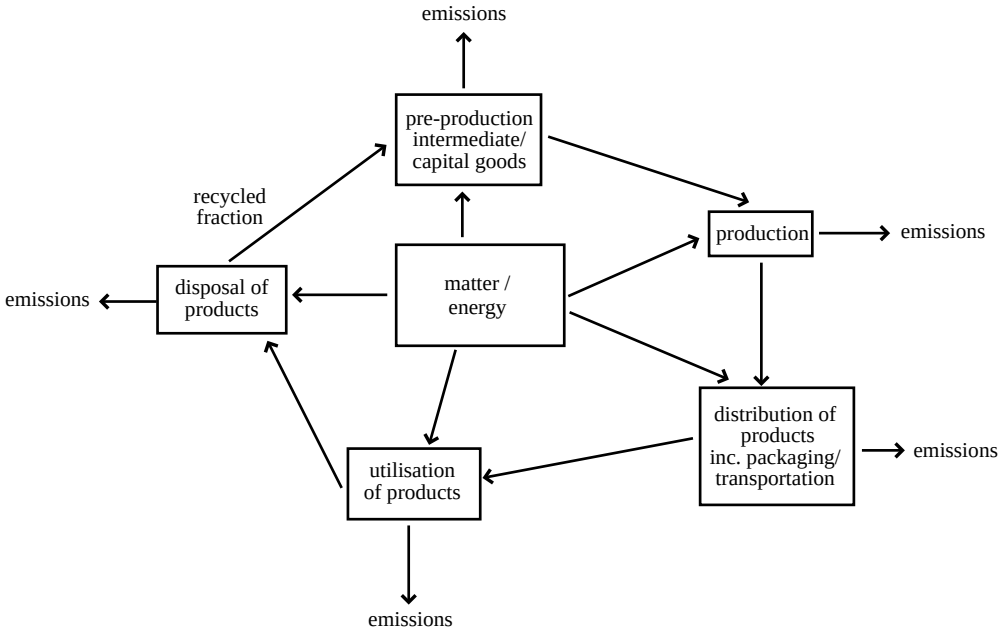

Figure 2. Inputs of matter and energy into the life-cycle of a product.

useful life and the environmental implications (for example, the reuseability, recyclability or biodegradability) of the disposal of its products at the end of these lives. The laws of thermodynamics (conservation of matter/energy, law of entropy) state that ultimately all matter/energy taken from the environment as 'resources' will be returned to it as 'wastes' and that the process of converting resources into wastes will inevitably increase overall entropy (disorder) in the system in which it is taking place. Figure 2 gives a schematic illustration of the transformation of matter/energy into products and thence wastes. Environmental impacts are associated with the extraction of matter/energy and the emissions of wastes that result from each stage.

It is a truism to say that, in order to know the environmental impact of a business, the flows of matter/energy as a result of its activities must be measured. Increasingly, for those impacts recognized as environmentally serious, there is a legal requirement for them to be measured. However, such requirements currently fall far short of what would be necessary for businesses to construct mass–energy balances (i.e. tables of material and energy inputs and outputs) for their operations, far less account for the environmental implications of their products' use and disposal. Yet if the impact of business on the environment is to be understood and effectively managed, it is difficult to see how the development of such an information system can be avoided.

The desirability of measuring corporate environmental throughput, over and above what is legally required, is increasingly being recognized by companies as a necessary precondition of effective environmental management and is being reflected in the growth of voluntary corporate environmental reporting. By 1993, over 100 companies had published environmental reports on a voluntary basis (Elkington & Robins 1993, p. 5), with the number rapidly growing, partly at least as a result of encouragement from business associations (including the International Chamber of Commerce and Confederation of British Industry), business environment networks (such as the World Business Council for Sustainable Development) and the European Commis-

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sion, with its voluntary Environmental Management and Auditing System (EMAS). While many of the early corporate environmental reports were largely descriptive and textual, there is a clear trend towards quantification in the assessment of environmental impacts.

It is interesting to compare these new efforts at environmental reporting, considering where they might lead, with the systems of financial accounting that have been adopted for the management of business and the economy. Business accounts are entirely analogous to mass balances. Money flowing into a business is balanced by money flowing out and a change in the value of net assets. Economy wide, the national accounts are explicitly constructed on an input–output basis, so that interactions between industries can be identified, as well as the producers and composition of final demand. Attempts to construct integrated environmental–economic accounting at the national level (see, for example, UN 1992) use the same techniques for environmental resources. If moving towards environmental sustainability really is an important, perhaps even overriding, imperative, then it seems likely that companies will need to account to society at large for their use of the environment with as much rigour as they do to their shareholders for the use of their money. Certainly this was the view expressed in DTTI *et al.* (1993), who identified the final stage in corporate environmental reporting as one 'based on the extensive use of quantitative methods such as life-cycle assessments and mass balances' (DTTI *et al.* 1993, p. 9).

Once the physical flows to and from the environment have been calculated, it becomes possible to consider a business's performance in relation to sustainability. Initially, the information enables the business to set targets for environmental improvement, which both DTTI *et al.* (1993, pp. 60–61) and Gray *et al.* (1993, p. 73) perceive as important stages in the development of corporate environmental reporting. Ultimately, if sustainability is the objective, the targets for improvement must comply with standards of sustainability. Gray *et al.* (1993, p. 273) consider that a sustainable organization is one which 'leaves the biosphere no worse off at the end of the accounting period than it was at the beginning'. It is important to recognize that such a zero pollution criterion is not the same as zero emissions, because of the environment's ability to absorb and neutralize a certain quantity of waste, but it is a demanding criterion nevertheless.

Gray *et al.* (1993) have also proposed that the notional expenditure required for the firm to make good any biospheric damage caused during the accounting period, which they call the 'sustainable cost', be identified in the company accounts as a measure of the firm's contribution to natural capital depreciation, analogously to the figures for depreciation of other assets. While a challenging task in practice, this valuation of the 'restoration cost' is also the technique recommended in UN (1993) as a means of linking the physical with the monetary accounts at the national level. For the firm it offers the intriguing prospect of being able, by deducting the sustainable cost from the operating profit, to arrive at a 'sustainable profit' figure which takes account of the environmental degradation caused by the company's activities.

In addition to identifying, and accounting for, their environmental impacts, it seems as important that businesses identify and correctly account their actual environmental expenditure, whether this is for abatement, source reduction, monitoring or regulatory compliance. This is because, unless firms know how much they are paying to prevent or monitor environmental damage, they will not feel the correct incentive to move towards products and processes that are inherently less environmentally damaging—and which could save them money. Ditz *et al.* (1995) report on

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Table 1. *Financial data for a project comparing conventional company analysis with a total cost assessment (TCA)*
(Source: Jackson 1993, p. 203.)

	company analysis	TCA	difference
total capital costs	$623 809	$653 809	6%
annual savings (BIT)[1]	$118 112	$216 874	84%
net present value, years 1–10	($98 829)	$232 817	336%
net present value, years 1–15	$13 932	$428 040	2972%
IRR, years 1–10	12%	24%	12%
IRR, years 1–15	16%	27%	11%
simple payback (years)	5.3	3.0	− 43%

nine case studies which were carried out on five large and four medium-sized firms, to see whether their environmental expenditures were correctly reported in their management accounts. In each case they found that they were not, but that, because environmental expenditures were sometimes subsumed under non-environmental headings, real environmental expenditures were substantially larger than they appeared in the accounts, financially justifying environmental improvement measures which before had not appeared economic.

Such revised accounting procedures have been called total cost assessment (TCA) (Jackson 1993, pp. 200 ff.). Table 1 shows one application of TCA to an investment that converted a solvent/heavy metal to an aqueous/heavy metal-free coating at a paper coating company. The company analysis column shows how the company's conventional accounting system assessed the project's costs and benefits. The TCA column includes costs and benefits that were accounted in the company analysis under headings which obscured their relation to the project. These hidden, or indirect, costs and benefits included costs of waste management, utilities (energy, water, sewerage), pollution control/solvent recovery and regulatory compliance. It can be seen that the project under TCA was substantially more profitable than with the conventional company analysis.

5. Moving businesses towards environmental sustainability

For companies that aspire to move towards environmental sustainability, environmental accounting and reporting are only two of several necessary management initiatives. Others include the adoption of a corporate environmental policy, of an environmental strategy and action plan to give it effect and appropriate communication of environmental outcomes, both internally and externally. The whole environmental management process needs to be integrated as in figure 3 (Gray *et al.* 1993, p. 91).

It may be imagined that the development and implementation of such an environmental management system, seeking to meet targets of continual environmental improvement, would be expensive and damaging to competitiveness. This can be true. However, there is now substantial evidence that this need not be the case.

The natural resources that are used in economic processes normally have to be purchased. The discharge of wastes during or at the end of a process represents a failure to use productively all the purchased inputs. The waste resource is also

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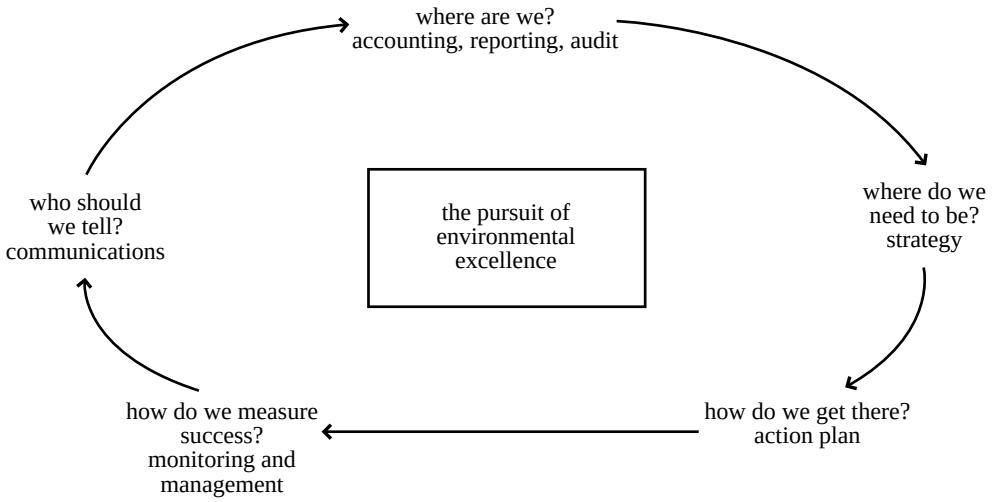

Figure 3. Stages in the pursuit of environmental excellence.

wasted money. Moreover, disposal of the waste will often have to be paid for. Waste management costs, while vital once costs have been generated, are also a waste of money in that they add nothing to the service delivered by a product. Finally, where the processes or products involved are potentially toxic or otherwise hazardous, they will be subject to regulations and controls, compliance with which may also be costly. Therefore, environmental management systems can actually result in net savings and improve competitiveness, if they lead to changes in company practices which save money in excess of the cost of implementing the management systems.

Smart 1992 (p. 3) gives the following five reasons why it can benefit corporations to move 'beyond compliance' with regulations in their environmental performance: preventing pollution at source can save money in materials and in end-of-pipe remediation; voluntary action in the present can minimize future risks and liabilities and make costly retrofits unnecessary; companies staying ahead of regulations can have a competitive edge over those struggling to keep up; new 'green' products and processes can increase consumer appeal and open up new business opportunities; and an environmentally progressive reputation can improve recruitment, employee morale, investor support, acceptance by the host community and management's self-respect.

Smart gives many examples of firms which have benefited financially for these reasons from voluntary environmental management initiatives.

(i) Between 1975 and 1992 the 3M Corporation saved more than $530 million from all the projects in its 3P (Pollution Prevention Pays) programme (Smart 1992, p. 13).

(ii) Feeling exposed because of its status as highest reporter of listed substances in the Toxic Release Inventory of the US Environmental Protection Agency, DuPont's CEO reports that the company embarked on an ambitious emissions reduction programme. 'The result is a total air emission reduction of 80% within one year. Our investment of just over $250 000 results in annual savings of $400 000—instead of a $2 million investment for an incinerator that would have cost an additional $1 million annually to maintain and operate.' (Smart 1992, p. 191).

(iii) Under its Tank Integrity Program, Chevron replaced all its old underground petrol tanks with double-walled fibreglass tanks, although this was not strictly required. However, a Chevron vice-president notes that 'Making right contamination

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from a leaking tank could cost the company $250 000 or more. If such a liability could be prevented with an expenditure of $25 000 to $50 000, then it's well worth it.' (Smart 1992, p. 103)

(iv) Pacific Gas and Electric adopted a programme on Customer Energy Efficiency, which involved it investing in the more efficient use of energy by its customers and sharing in the resulting financial savings. Its 1991 measures under this programme reduced emissions of nitrogen oxides by 445 tons, of sulphur oxides by 120 tons and of carbon dioxide by 340 000 tons, and earned the company $45.1 million before taxes.

The Smart (1992) 'beyond compliance' studies were of US corporations, but very similar results were reported in a recent study of UK business. 'The main benefits reported from investment in cleaner production systems were cost savings through improved waste management, improved public image for the company and staff motivation, cost savings through better energy management, improved process efficiency, and increased profitability. Substantial savings could be made though energy management systems and relatively simple 'housekeeping' modifications to production processes. Longer term gains in competitiveness were expected by many firms, mainly large corporations with sophisticated strategies for environmental management.' (Christie *et al.* 1995, p. xi).

6. Generalizing best environmental practice

In a market economy the price system is the single most important mechanism for allocating resources. Where prices include all the relevant costs of production, and providing basic conditions of market competition are fulfilled, the price system will ensure an efficient (though not necessarily an equitable) allocation of resources, in the sense of achieving an outcome such that it is not possible to make anyone better off without making someone else worse off.

However, impacts from economic activity on the environment routinely escape the price mechanism, affecting people who are not involved in and do not benefit from the activity. This 'externalization' of some of the costs of production and consumption is both inefficient and inequitable and provides the basic rationale for governmental environmental policy and intervention.

The companies whose experiences of environmental management have been briefly reviewed above have shown how far it is possible to improve environmental performance alongside conventional business goals through voluntary commitment. Their actions are equivalent to the voluntary internalization of costs which before were escaping their management systems and reducing the welfare of others. The case studies show the extent to which these companies have been able to turn such internalization to their competitive advantage in order to remain profitable in an economic context which currently permits the externalization of costs to continue.

However, there is little prospect that the necessary transformation to 'clean business' can be achieved through voluntary action alone. Companies like those above are in a small minority in business as a whole. Most do not proceed voluntarily down the route of environmental improvement. Indeed, Christie *et al.* (1995, p. 216) report a widespread view among the environmentally leading companies they surveyed that 'diffusion (of cleaner production systems) so far was patchy and disappointing given the imperative of the transition towards sustainable development, and the fact that cleaner production techniques hold out the prospect of integration of business goals with environmental protection and of major new opportunities for product and

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process innovation'. The diffusion is slow and patchy due to organizational and market failures, especially in the small business sector. But it also seems likely that, in competitive markets, if the option of externalizing costs is available, the baseline for business profitability will be set by taking advantage of that option. Only exceptional companies will be able to maintain profitability where others routinely externalize costs. The purpose of government intervention in such a situation is to change the competitive rules, enforcing the internalization of environmental costs, so that the firms which achieve it most efficiently have a competitive advantage rather than the reverse.

This is not the place for a detailed exposition of the possible ways government may seek cost internalization. Jackson (1993, pp. 301 ff.) lists regulatory programmes, economic instruments, the provision of training and information, including eco-labelling systems, voluntary agreements with industrial sectors (usually backed up by the threat of regulation), the imposition of liability for environmental damage and insistence on full disclosure. Government can also seek to use its power as a major purchaser by applying environmental conditionalities to its contracts.

Both Jackson (1992, pp. 301 ff.) and Christie *et al.* (1995, p. 218) are in agreement that regulations are the most important factor in the promotion by government of clean or cleaner production. It is also generally desired by firms that are committed to proactive environmental management themselves. In a survey of environmental leaders carried out by Christie *et al.*, 'very few user-company respondents wanted to see voluntary approaches in place of legislation: they wished to see environmental requirements apply to all firms in order to avoid the problem of free-riding' (Christie *et al.* 1995, p. 218). Other firms tend to be nervous about stringent regulations, believing them to impose costs and damage business competitiveness. Such fears are transmitted to politicians, who worry in their turn about closures, corporate relocation and unemployment.

There is in fact very little evidence that environmental regulations to date have harmed competitiveness in any way. Not only is there the experience cited earlier of the firms who had gone beyond regulatory requirements and improved their competitive position; in addition, a number of studies have sought but failed to find significant evidence of economic disadvantage from environmental regulation. Surveying these studies, the OECD reports that 'the trade and investment impacts which have been measured empirically are almost negligible' (OECD 1996, p. 45) Similarly, De Andraca & McCready (1994, p. 70) of the Business Council for Sustainable Development roundly dismiss fears that environmental regulation can damage an economy: 'concerns about pollution havens, free riders or an exodus of capital and jobs from countries with tough standards are unsubstantiated'. They emphasize in contrast the competitive benefits to be gained by innovation and eco-efficiency induced by stringent regulations and high prices of environmental resources.

Porter has explored in detail the factors that seem to contribute to competitive advantage. He is in no doubt about the potential benefits for competitiveness of corporations pushing themselves, or being pushed by regulations, towards improved environmental performance: 'Stringent standards for product performance, product safety, and environmental impact contribute to creating and upgrading competitive advantage. They pressure firms to upgrade quality, upgrade technology and provide features in areas of important customer (and social) concern . . . Particularly beneficial are stringent regulations that anticipate standards that will spread internationally. These give a nation's firms a head start in developing products and services that

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will be valued elsewhere. Social concerns such as the environment are increasingly differentiating factors in advanced markets, and regulation influences the response of a nation's firms to them . . . Firms, like governments, are often prone to see the short-term cost of dealing with tough standards and not their longer-term benefits in terms of innovation. Firms point to foreign firms having a cost advantage. Such thinking is based on an incomplete view of how competitive advantage is created and sustained. Selling poorly performing, unsafe, or environmentally damaging products is not a route to real competitive advantage in sophisticated industries and industry segments, especially in a world where environmental sensitivity and concern are rising in all advanced nations.' (Porter 1990, pp. 647–648).

Even though regulations my have a broadly neutral, or even positive economic effect overall, there is widespread agreement among economists and policy analysts that they are a less efficient way of achieving many environmental goals than the use of economic instruments, such as environmental taxes and charges, tradable permits and other means of direct financial incentives for environmental improvement. There are several reasons for their greater efficiency.

(i) They equalize the marginal cost of abatement across polluters, so that all the cheapest options for abatement are implemented first.

(ii) They can be as effective for diffuse sources of pollution, which are difficult to regulate, as for point sources.

(iii) By becoming incorporated into the prices of products, environmental taxes in particular give incentives to consumers as well as producers to shift away from environmentally intensive consumption.

(iv) Because environmental taxes and charges are payable on all particular uses of the environment (unlike regulations which permit its free use once the regulatory requirements have been met), they give an incentive for continual environmental improvement at all levels of use.

(v) By raising revenue, environmental taxes provide the means to give earmarked subsidies, where appropriate, to achieve environmental improvements beyond those arising from the price effect, or to reduce distortionary taxes elsewhere. Where these are labour taxes, greater employment may result.

A variety of environmental taxes and charges have been implemented, especially in North European countries, in recent years (see OECD 1995*b* for a survey). Although they allow society as a whole to achieve environmental goals more cost effectively than total reliance on regulation, in one way environmental taxes and charges raise more serious competitiveness issues than regulations for firms that are in particularly environmentally intensive sectors. This is because, as noted above, after compliance with regulations firms may use the environment without further payment; with environmental taxes firms pay for all use of the environment, even that which is within regulatory limits. Of course, provided the revenues from environmental taxes are used to reduce other business taxes, overall effects on business competitiveness from the tax will be negligible and clean businesses will actually benefit from it.

While, as with regulations, there is no evidence that environmental taxes do have a negative effect on competitiveness, most countries that have introduced such taxes have sought to reduce even the possibility of such an effect by giving vulnerable firms or sectors exemptions or concessions. These reduce the economic efficiency of the environmental tax and reduce the economic advantage to be gained from clean production systems. It is arguable, however, that they are justified if they prevent companies' relocation to countries with lower environmental standards.

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The Western European experience of environmental taxation could now develop in one of several different directions. Several countries clearly desire to push ahead with more ambitious schemes, but what they are likely to enact unilaterally is bound to be constrained by concerns about national competitiveness and distortions in the EU single market. However, if the EU were to introduce minimum energy taxes and a carbon/energy tax along the lines of the European Commission's 1991 proposal, as several EU countries clearly recommend, a further range of opportunities for unilateral innovation and experimentation would open up and some of the more ambitious schemes might start to be implemented. However, it is still not clear whether and how such a common introduction of taxes at the European level will come about. For the present, it only seems certain that governments will continue to introduce environmental taxation bit by bit, attracted by the combination that such taxation seems to offer of cost-effective environmental policy and a source of government revenue.

The imposition of environmental taxes is not the only way the prices of goods and services may be made to reflect environmental costs or environmental risks (which relate to a possibility of environmental costs in the future). Two other ways which are gaining an increasing profile in environmental policy, and which have a fundamental impact on business operations, are the assignation to firms of liability for the environmental impact of their operations, and of responsibility for their products through to their disposal.

Environmental liability refers to the legal responsibility of a firm for any environmental impact it may cause and its consequent obligation to pay compensation to parties injured by the damage and/or for any environmental restoration that may be required. The current trend is away from fault-based liability to 'strict' liability, which attaches to the perpetrator of damage irrespective of fault. Strict environmental liability has applied for some time to certain activities in the United States and there have been ongoing discussions in the European Union for a number of years around a possible directive in this area, although so far without effect.

In principle, environmental liability should be insurable, as with other risks, converting possible future environmental costs into present financial costs, and so providing an incentive to firms to reduce their risks, and therefore their insurance premia, to a socially satisfactory level. In practice, the uncertainties associated with environmental impacts, and the size of potential costs, have caused many insurers to withdraw from underwriting liability for environmental damage (Simmons & Cowell 1993, p. 356). Unavailable, or very expensive, insurance may in turn have the effect of deterring producers from business of certain kinds altogether. Where the potential environmental liabilities relate to past activities, as with much contaminated land, this may result in an inability to find private sector companies, or finance, either to decontaminate or to redevelop such sites. Thus, although strict environmental liability provides powerful incentives to firms to manage and reduce their environmental risks, its possible deterrent effects on desirable activities should also be borne in mind, and guarded against, when legislation on environmental liability is introduced.

Producer responsibility, the second way that is discussed in this section of internalizing environmental costs, in this case especially the costs of disposal, operates by making producers responsible for their products' disposal at the end of the products' useful lives. The first application of producer responsibility was the German Packaging Ordinance of 1991, which required producers to take back their packaging waste and mandated minimum recycling levels. Since then the approach has been, or will

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be, extended to electronic goods, batteries and automobiles (Meyer-Krahmer 1996, p. 8). Combined with the current trend of waste disposal becoming more expensive, through the imposition of waste disposal taxes and subject to increasingly strict regulations designed to increase the proportion of waste that is reused and recycled, the application of producer responsibility can be expected to exert a powerful influence on every aspect of product development, from their initial design to the way they are marketed.

7. Conclusions

This paper has proceeded from the perception that sustainable development has already to some extent, and will increasingly, become a fundamental objective of government policy and that the general transformation of business into clean business is an imperative of sustainable development.

For firms to contribute to national goals of sustainable development, they first of all require an environmental management system that enables their environmental impacts to be measured and monitored. Several such systems now exist and are increasingly being employed and reported on by companies. There is now substantial evidence that the disciplines of adopting an environmental management system, and the more efficient use of resources to which this can lead, can result in net financial savings. Leading companies that use environmental management and accounting systems to become clean businesses may well save costs and gain competitive advantage from doing so.

Despite this potential for savings, the diffusion of cleaner production methods is slow and will remain slow without determined government policy. There is general agreement both within business and outside that legislation is both necessary and desirable if ambitious environmental objectives are to be pursued. So far, government regulations have been the principal driving force to improve environmental quality. However, the same environmental goals can be achieved more cost effectively, and with greater stimulus to innovation to develop cleaner production methods, if other policy instruments, including environmental taxes, are used as well.

Because they allow other taxes on business to be reduced, environmental taxes are of particular benefit to clean businesses. However, because of their effects on the competitiveness of environmentally intensive sectors, such taxes may need minimum harmonization at the European level to become more widely introduced.

Without taxes on environmentally harmful products and processes, or some other means of ensuring that the price mechanism reflects the environmental benefits of clean business, it is hard to imagine clean businesses being generally more competitive and commercially successful than businesses which can reduce their costs by failing to exercise similar environmental care.

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