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SPECIAL ISSUE: CLEAN TECHNOLOGIES

EUROPEAN COMMISSION
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ENGLISH VERSION

ABOUT THE IPTS REPORT

The IPTS Report was launched in December 1995, on the request and under the auspices of Commissioner Cresson. What seemed like a daunting challenge in late 1995, now appears in retrospect as a crucial galvaniser of the IPTS' energies and skills.

The Report has published articles in numerous areas, maintaining a rough balance between them, and exploiting interdisciplinarity as far as possible. Articles are deemed prospectively relevant if they attempt to explore issues not yet on the policymaker's agenda (but projected to be there sooner or later), or underappreciated aspects of issues already on the policymaker's agenda. The long drafting and redrafting process, based on a series of interactive consultations with outside experts, guarantees quality control.

The clearest indication of the report's success is that it is being read. An initial print run of 2000 for the first issue (00) in December 1995 looked optimistic at the time, but issue 00 has since turned into a collector's item. Total readership rose to around 10,000 in 1997, with readers continuing to be drawn from a variety of backgrounds and regions world-wide, and in 1998 a shift in emphasis towards the electronic version on the Web has begun.

The laurels the publication is reaping are rendering it attractive for authors from outside the Commission. We have already published contributions by authors from such renowned institutions as the Dutch TNO, the German VDI, the Italian ENEA and the US Council of Strategic and International Studies.

Moreover, the IPTS formally collaborates on the production of the IPTS Report with a group of prestigious European institutions, with whom the IPTS has formed the European Science and Technology Observatory (ESTO), an important part of the remit of the IPTS. The IPTS Report is the most visible manifestation of this collaboration.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the IPTS; to these one could add the Italian translation volunteered by ENEA: yet another sign of the Report's increasing visibility. The fact that it is not only available in several languages, but also largely prepared and produced on the Internet World Wide Web, makes it quite an uncommon undertaking.

We shall continue to endeavour to find the best way of fulfilling the expectations of our quite diverse readership, avoiding oversimplification, as well as encyclopaedic reviews and the inaccessibility of academic journals. The key is to remind ourselves, as well as the readers, that we cannot be all things to all people, that it is important to carve out our niche and continue optimally exploring and exploiting it, hoping to illuminate topics under a new, revealing light for the benefit of the readers, in order to prepare them for managing the challenges ahead.

Preface

This 'IPTS Report' special issue is devoted to 'clean technologies', which are new technological solutions offering considerable potential in the context of a sustainable economic development.

The European Union's commitment to achieve a sustainable development path has become a permanent characteristic for most of its policies during the last decade. Indeed, in 1997 the Amsterdam Treaty has introduced a renewed impetus in this direction by including a stronger commitment on environment, with an explicit obligation to integrate environmental requirements into all EU policies and actions.

Of course, sustainable development is not only of concern to the EU, but a global issue at stake. The Kyoto Summit on Global Warming, held in December last year, made clear that the current pattern of development entails conflicts between development and environment, which cannot be permitted to continue. Hence, the importance of creating an appropriate legislative framework and exploring new technological avenues, which will result from increased research efforts.

At present, the appreciation of the potential of clean technologies, on the one hand, and the problem of consumer demand increase, on the other, represent part of the challenge policy-makers face when defining legal *framework conditions. Policies have to aim at achieving a competitive economy, combined with less environmental degradation, improved resource efficiency of energy and raw materials, and higher employment rates.*

The EU R&D policy, through its Framework Programme 5 and the Joint Research Centre of the European Commission, are prepared to support policy-makers in their task of providing an adequate legislative framework to enhance sustainability without undermining European competitiveness.

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C O N T E N T S

SPECIAL ISSUE: CLEAN TECHNOLOGIES

An Editorial Outline of Aspects of "Clean Technologies"

Vera Calenbuhr, *IPTS*

Issue: The implementation of integrated technology concepts aiming at reducing the use of toxic materials and improving material productivity is becoming increasingly more widespread. Several surveys among institutional investors and industrialists have shown that sustainable development along its three dimensions - environment, social, economic - is playing a role in entrepreneurial decision making processes.

Relevance: Several national initiatives, the Amsterdam treaty of the EU, and also the economy, finance and trade ministers of the OECD[1] now endorse sustainable development as a principal policy objective. The complexity of the clean technology issue requires flexible regulatory tools that enable companies to fully explore the potential of integrated technologies. It is instructive to give an overview of the potential and the limitations of clean technology concepts in view of changing policy objectives.

Originally, the main emphasis of the environmental debate, policy and practice was on limiting the release of toxic materials into the air, water and soil

The environmental debate has shifted from end-of-pipe technologies to more complex issues such as resource depletion, waste reduction, bio-diversity, global climate change etc.

Originally, the main emphasis of the environmental debate, policy and practice was on limiting the release of toxic materials into the air, water and soil. Regulations addressed this issue by prescribing limit values and norms which prompted industry to fit filters, catalytic converters etc. onto existing equipment. Over the years, a whole new branch of industry emerged: environmental technology, most of which is represented by these so-called add-on or end-of pipe technologies. Despite their positive effects - making air and water cleaner - add-on technology has not been without its critics from industry, policy makers and environmentalists. The devices are expensive for a company and often do not really solve an environmental problem, but rather shift the disposal of a pollutant from one medium to another.

Parallel to the diffusion and implementation of end-of-pipe technologies (which still continue) the environmental debate has shifted to more complex issues such as resource depletion, waste reduction, bio-diversity, global climate change and others. Industry's response, partly on a pro-active basis and partly complying with new legislation has been to implement technologies with a different objective: rather than limiting emissions at the end of the process the new focus has become reducing resource use and limiting the utilization of toxic substances along the life cycle of a product.

This can be achieved in several different ways: closing material flows inside and outside of the company, better logistics, improved energy efficiency, redesigning production processes and products, better process control, substituting raw materials, use of fewer toxic chemicals and using new technologies. The clean technology issue is not just about radical innovation and functional changes. There is already a vast body of empirical evidence which shows that marginal process and product design modifications can bring about significant reductions in the use of materials and the quantity of pollution, whilst improving the competitiveness of the firm. Closer inspection shows that the integration of resource-saving measures in the production process is to a considerable degree an organizational challenge and a result of good stewardship rather than being entirely a technical problem.

The implementation of cleaner technologies - as defined loosely above – may require rearrangement of strategies inside and outside a company. Many firms report that they have become more competitive and have higher return on investment. Despite financial incentives and the fact that the changes are not necessarily complex, small and medium sized companies (SMEs) face difficulties in realizing clean technology concepts. While many large companies are systematically integrating their processes, SMEs lag behind in this development. The article by Eder and Fresner analyses this situation and highlights what is possible for SMEs and where the limits are.

The environmental debate, the technological solutions and environmental regulation have co-evolved to higher degrees of complexity. Command and control approaches have been supplemented or replaced by more flexible market-based instruments. Regulation must on the one hand assure the realization of policy objectives. On the other hand it should not lead to undesirable technology lock-in situations. Moreover, it should avoid the implementation of technically inferior solutions. These imperatives are very difficult to achieve. Therefore, voluntary agreements are discussed as an alternative. They may be flexible on the one hand, but may not always lead to the desired effects on the other. An interesting variation on that theme, a voluntary approach based on consensus while at the same time keeping tighter regulations as a fall back mechanism is currently being used in the Netherlands and the US. Celia Greaves reports on the trials being undertaken using this so-called covenant approach that is now being evaluated.

The integration of cleaner production measures may sometimes require companies to exchange materials with one another. In extreme cases the waste of one company may become a resource for another firm, changing the goal from waste minimization to waste flow and waste use optimization. In this way, companies form networks and achieve considerable environmental as well as economic benefits. The article by Cohen-Rosenthal and McGalliard from Cornell university describes the potential of so-called eco-industrial parks based on this symbiotic model.

The biggest savings at the level of resource consumption can be achieved if the idea of a product is looked at from a different angle. What a consumer wants is in many cases not the material product as such, but rather its performance i.e. the service he or she obtains from it. Thus, one major trend today is that many companies are shifting from selling a product to selling a service and so retaining responsibility for the underlying product throughout its life cycle. Walter Stahel describes several examples of companies selling performance rather than material goods and the implication at management and policy level.

Cleaner technologies entail closing material flows, improving logistics, improving energy efficiency, redesigning processes, substituting raw materials, and so on

In the eco-park model there is a kind of symbiosis, one company's waste is another's raw material, reducing net resource usage at a multi-firm rather than individual firm level

Another telling sign today is that quite a few companies are shifting from selling a product to selling a service and so retaining responsibility for the underlying product throughout its life cycle

Investors are increasingly recognizing the role of environmental performance as an indicator of a company's competitiveness and good management

Although innovative technologies have an important role, supply and demand need to be brought in line in order to adjust resource consumption to a degree that is compatible with the carrying capacity of the planet's stocks

A closer look at the motivations that lead companies to implement cleaner technologies reveals several interesting factors. The first and most important factor still is cost. Clean technologies (covering the vast spectrum of approaches and initiatives described above) can be cost saving due to the reduced consumption of resources, reduced costs for safety, cleaning and remediation, etc. These are all factors that have a direct impact on the bottom line of a company. However, clean technology concepts do not automatically result in cost savings. Among several possibilities of optimizing a firm's activities internally and in relation to other business partners and the customer, not all environmentally friendly solutions are the most cost effective ones. In many cases, the identification of an environmentally good and cost saving solution requires a considerable effort from a firm. This has lead many companies to develop tools such as indicators that help them to link design changes, environmental impact and cost. Although these initiatives have only been started recently, they contribute to include environmental factors to a set of other business factors (Gameson, to be published).

Besides cost, other factors play an important role as well. Many companies that see themselves as being concerned and committed to environment and sustainable development underline their social responsibility (BATE news service April 1998; Schmidheiny et al, 1997). Another factor is the public image that a firm has. Today, a company can less and less afford to have a negative image. Besides customers, shareholders ask environmental details about a company's performance and management. There is a growing perception among industrial agents, raters in banks and investment portfolio managers that companies with a good environmental record and environmental management systems in place are on the whole better managed than other firms. A recent survey among institutional investors has shown that around two thirds rate environmental factors as important for improving a company's competitiveness (BATE news service, April 1998).

Compared to the often highly polarized image that industry has to live with (being the creators of wealth and labour on the one hand, while being the bad polluters on the other hand), the picture that one gets from companies implementing clean technologies looks considerably more positive. One has to be careful, however, with general judgements and conclusions. Clean technologies are becoming an important contribution to reducing environmental impact. However, integrated technologies are an emerging trend and it may take years before these technologies enter the mainstream. So, most of the success stories of clean technologies represent the smaller part, mostly very innovative firms, of the whole industry community. Moreover, while large companies have also the largest potential for change, it may take many years to integrate production processes in industrial giants such as multi-national companies. Despite this, those companies embarking on new and environmentally more benign ways are certainly the pioneers of the often cited post-industrial age.

Despite an enormous increase in material productivity since the beginning of the industrial revolution material consumption has increased because demand has increased faster still. Although clean technologies use resources much more efficiently, the overall material consumption is likely to increase. In industrialized countries demand is still growing and there is a trend of using short lived material intensive products. The increasing population and standard of living in many developing countries will also lead to an enormous increase of material consumption. It is expected that the environmental burden on the planet will at least double over the next fifty years. It follows that we have to half the environmental impact at a global level, if the overall environmental situation shall not become worse. It becomes obvious that clean technologies may have the potential to become industry's contribution to sustainable development in industrialized countries as well as developing countries. However, industry can hardly solve the problem alone. Supply and demand need to be brought in line in order to adjust resource consumption to a degree that is compatible with the carrying capacity of the planet's stocks. This requires an effort of all the players involved, industry, authorities and consumers. There are several interesting studies and scenarios by governments and research institutions that deal with the potential of clean technologies in integrated concepts. See for example "81 Options - Technology for Sustainable Development" a study commissioned by the Dutch Ministry of Housing, Physical Planning and the Environment (1997) or the new report to the Club of Rome "Factor Four", by von Weizsaecker, Lovins and Lovins (1997). The problem that demand increases faster than material productivity, leading to an overall increase of resource use is an important issue that we have not been able to discuss in detail in this special issue due to space limitations. Other important issues such as the elaboration of Best Available Technologies (BATs), technology diffusion, the relation between clean technologies and trade and the important role financial institutions are beginning to play in making industrial production have a smaller environmental impact could not be discussed in detail for the same reasons, too. Nevertheless, the examples chosen show that integration on the one hand and cooperation between several players such as industry (suppliers, producers, distributors etc.), authorities and consumers on the other are key concepts that can be found running through technical, organizational and policy-making issues in this area.

Keywords

eco-efficiency, integrated technologies, end-of-pipe technologies, integration, cooperation

Note

1- Annual meeting on 28-29/0498, Paris.

References

- *Business And The Environment* (BATE news service). April, Volume IX, No. 4, 1998.
- Gameson, T., *Business Weighted Environmental Indicators.* EUR Report (IPTS). To be published in september 1998.
- Schmidheiny, S., Chase, R. and DeSimone, L., *Signals of Change - Business Progress Towards Sustainable Development.* WBSCD Publications, Geneva, 1997.
- von Weizsaecker, E.U., Lovins, A.B. and Lovins, L.H., *Factor Four: Doubling Wealth - Halving Resource.* The new report to the Club of Rome. Earthscan Publications Ltd, London, 1997.
- Weterings, R., Kuijper, J. and Smeets, E., *81 Options - Technology for Sustainable Development.* Report commissioned by the Dutch Ministry of Housing, Physical Planning and the Environment. Apeldoorn, 1997.

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The Role of Cooperative Cleaner Production Projects

P. Eder, *IPTS* and J. Fresner, *Stenum GmbH*

Issue: Over the last decade a considerable number of cleaner production projects and programmes have been carried out by SMEs in conjunction with consultants, local authorities and international organizations so as to improve the eco-efficiency of the companies' production systems. Sufficient information about the outcome of such initiatives is now available to make it possible to appreciate their contribution to achieving forms of production compatible with sustainable development.

Relevance: Increased eco-efficiency, i.e. decreased material and energy intensity of production and lower emissions, is a prerequisite for sustainable economic development in the upcoming decades. Cooperative cleaner production projects allow SMEs to engage in improving their eco-efficiency through process and management optimization and redesign by trying to compensate the specific disadvantages faced by SMEs when compared to large companies.

Introduction

The reactive and curative approach has predominated in environmental protection since the 1960s. Problems with emissions of pollutants from industrial sources have tended to be addressed by the utilization of end-of-pipe pollution control technologies. These approaches reduce the direct release of some pollutants to achieve regulatory compliance but do not really solve the environmental problems as they shift pollution from one environmental medium to another. Moreover environmental protection is frequently seen as a burden because end-of-pipe treatment causes extra costs. The cleaner production approach aims at avoiding these shortcomings of traditional environmental protection. It prevents the production of pollutants instead of treating waste and emissions in end-of-pipe treatment plants. The idea of cleaner production came up in the 1970s in individual large companies and it has become more wide-spread in the 1990s with programmes and projects involving bigger numbers of participating companies and focusing on SME. These initiatives represent an important factor for sustainable development.

Definition of cleaner production

Cleaner production is a preventive strategy to minimize the impact of production and products on the environment by applying cleaner technologies and organizational measures. It reduces the impact of industrial plants on their environment by tracking their waste and emissions to their respective sources in the processes and defining measures to eliminate the problems there.

The basic idea is to shift from the question:

- 'What shall we do with our waste and emissions?' to
- 'Where do our waste and emissions come from and what can we do to prevent their production at source?'.

This approach includes organizational changes, motivation and training for good housekeeping as well as changes in raw materials, process technology, and internal recycling ('Cleaner Technology'). It introduces the idea of material and energy flow management into the companies. Nielsen (1994) defines 'Cleaner Technology' as follows:

'Cleaner Technology is the conceptual and procedural approach to the development, purchase and use of processes and products preventing and reducing internal and external environmental problems throughout the product life cycle by integrating options to:

- minimize volumes and hazards of gaseous, liquid and solid wastes;
- minimize the risk of accidents involving chemicals and processes;
- minimize consumption of raw materials, water and energy; and
- use substitute chemicals and processes less hazardous to human and ecological health.'

Cooperative cleaner production projects in SMEs

One of the first cleaner production initiatives was started by 3M in the 1970s. Today, from among the many businesses studying or implementing cleaner production, about 120 companies, mainly large ones such as BP, 3M and Sony, have come together in the World Business Council for Sustainable Development. Although some of these companies are still at an early stage of implementing cleaner production strategies, they have recognized that there are advantages to an integrated approach to environmental protection and that it enhances competitiveness.

SMEs took up the idea of cleaner production later than the bigger companies. Generally it was not before the 1990s that they became active in the field. This can be explained by the fact that SMEs have often problems finding free capacity for innovative initiatives due to limited personnel, limited possibilities for investments and for R&D. Cleaner production reached SMEs when cooperative cleaner production projects were established to compensate for their specific problems. Cooperative cleaner production projects bring together companies, universities, regulatory agencies and international organizations to implement cleaner production programmes in companies.

Among the most prominent European cooperative projects are the Dutch PRISMA project, the AIRE/CALDER project in the UK, the CATALYST Merseyside project, the SPURT project in Denmark, the LANDSKRONA project in Sweden and the ECOPROFIT and PREPARE projects in Graz, Austria (Gee, 1995; Ulhøi, 1997). The UNEP (United Nations Environment Programme) began its cleaner production programme in 1989. It works with more than 100 organizations to implement cleaner production initiatives in over 60 countries. Together with UNIDO (United Nations Industrial Development Organization) it has established National Cleaner Production Centres in the Czech and Slovak republics, in Hungary, India, China, Mexico, Brazil, in Nicaragua, Costa Rica, El Salvador and some more countries. UNEP's International Cleaner Production Information Clearinghouse provides data on about 600 technical cleaner production case-studies all over the world. The Austrian ECOPROFIT and PREPARE projects started in 1991 and have included more than 200 companies from the textile, pulp and

Cleaner production is a preventive strategy to minimize the impact of production and products on the environment by applying cleaner technologies and organizational measures

Large companies were the first to adopt the cleaner production approach

A number of European and world-wide clean production initiatives have involved SMEs drawn from a wide range of industrial sectors

Programmes usually involve input from consultants, training, workshops and then sharing of experience

paper, food processing, machine building, wood working, printed circuit board manufacturing and galvanising industries as well as other sectors.

Cooperative cleaner production projects typically evolve in the following stages:

1. creating awareness concerning the prevention of pollution;
2. finding the source of wastes and emissions;
3. defining a programme to reduce emissions and increase resource efficiency;
4. implementing and documenting cleaner production options.

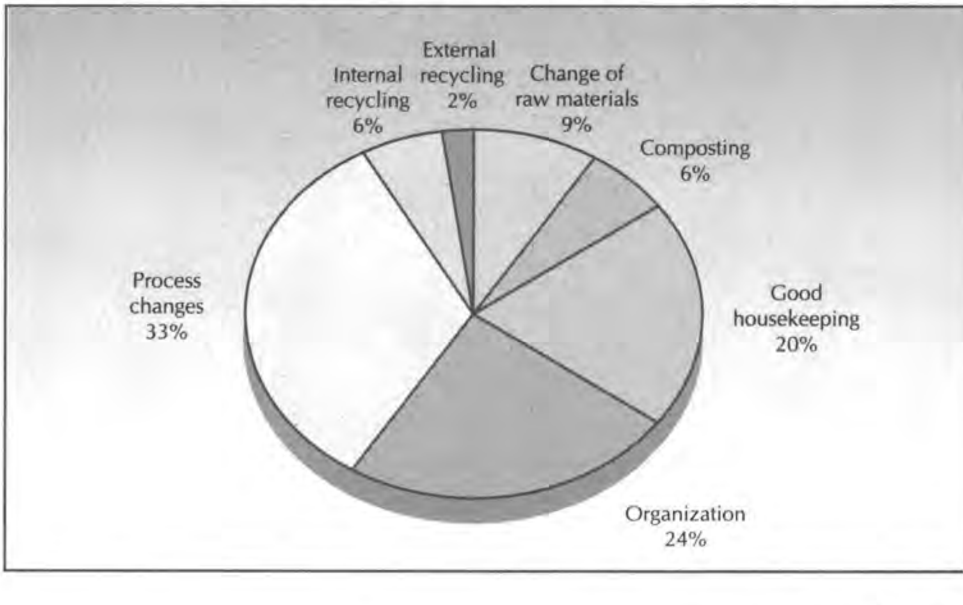
Usually the companies participating in cooperative Cleaner production projects are coached by external consultants that train the staff, visit the companies and bring participants from different companies together in common workshops to share knowledge and experience. For example the ECOPROFIT Programme is offering 10 workshops on the issues of waste avoidance, establishing an environmental programme within the company, waste management, material flow analysis, hazardous materials, laws and regulations, in-company energy analysis, assessment of environmental costs, ecological purchasing and eco-design, eco-controlling and indices.

The following types of cleaner production measures are typically identified and/or implemented in Cooperative cleaner production projects:

- good housekeeping with materials and energy;
- training of employees, better logistics, improvement in data availability and communication between departments;
- substitution of raw and auxiliary materials by less harmful ones or ones that can be used more efficiently or can be recycled internally or externally;
- modifications of products to eliminate production steps with major environmental impact;
- process modifications to minimize waste and emissions;
- internal recycling;
- introduction of waste into external recycling networks.

Figure 1, below, gives the quantitative distribution of the different types of cleaner production measures in the ECOPROFIT/ PREPARE project.

Figure 1. Different types of cleaner production measures in the ECOPROFIT/PREPARE project



Achievements and limitations of cooperative cleaner production projects

Generally, experience shows that cooperative cleaner production projects are successful in improving the eco-efficiency of SMEs, although sometimes the reduction in material and energy use are relatively small in comparison to the scale of the company's activities. Table 1 gives typical results for companies participating successfully in cooperative cleaner production projects. The results of cooperative cleaner production projects are related to the type of innovation that triggers an increase in eco-efficiency. Generally, we can

Although generally successful, programmes involving SMEs do not always achieve results on a scale comparable to the companies' business

Table 1: Measures and results of ECOPROFIT/PREPARE cooperative cleaner production projects

Sector	Turnover [Million ECU]	Number of employers	Measures	Results
metal processing	286.9	1100	creating responsibilities, waste logistics	-50% solid waste
metal processing	32.9	340	waste logistics, optimization of paint-shop (paint and guns)	-30% solid waste, -30% paints
electrical ind.	30.4	243	waste logistics, increasing batch sizes by quasi 'continuous' manufacturing of cables	0.21 million ECU/yr from less waste and better logistics
electronic ind.	17.9	328	better dosing of diverse chemicals, optimization of waste water treatment plant	0.14 million ECU/yr from less chemicals and recycling of cleaning fabrics
woodworking	71.7	860	change to water based paints, efficiency of cutting textiles, waste logistics	-40% solid waste, 0.35 million ECU/yr from less textiles
food processing	18.65	108	reuse of water, better maintenance of fat separators	-40% COD[1] in waste water, 30% water use
pulp and paper	109	420	flow analysis of Cadmium, composting sludge	-25% sludge to disposal
textile	2	26	optimization of boiler, elimination of washing cycles, better control of washing, exact dosing of chemicals	elimination of Chromium, -30% water, -30% steam

Three kinds of innovation are involved: optimization, redesign and function innovation. The most radical innovation is often the most effective, but inertia is often an obstacle to implementation

A number of factors militate against the effectiveness of cleaner production innovation implementation in SMEs

distinguish three ideal kinds of innovation: optimization, redesign and function innovation. Optimization focuses on improving existing processes and does not essentially modify the system of production but rather increases the efficiency of the system by making slight modifications (e.g. reducing heat losses by better insulation). Redesign partly changes the actual design of existing processes. Specific features of the system are changed, for instance by choosing to use materials that can be made suitable for reuse in the disposal stage or that are less eco-toxic (e.g. substitution of FCHC by non-halogenated hydrocarbons in air-conditioners). The system concept however remains largely unchanged. Function innovation departs from the system concept and develops new systems which perform the same function better. This can result in a radical change as to how the function is fulfilled (e.g. more intelligent architecture that makes air-conditioners obsolete) (Weterings, *et al.*, 1997).

Most cleaner production options reported by cooperative projects can be classified as optimization or redesign. They typically reduce the material or energy intensity of companies or individual processes within companies by 5 to 50 %. Cleaner production case-studies quite often report considerable reduction of an individual energy or material flow within a company, with the flaw that the affected flow is relatively irrelevant within the context of the entire production process. This may partly be due to the fact that the really important flows are already fairly well optimized before the start of the cleaner production project as they represent an important cost factor. In practice too, cooperative cleaner production projects are often the province of environmental managers. They are not always well integrated with the mainstream of the business and so cannot always influence innovation processes. Products of SME are often highly dependent on the integration in the entire production chain and control only a small part of the product life cycle, so the possibilities of designing products in a completely new way are limited. (Even the cooperative approach seems to be unable to compensate for this relative disadvantage of SMEs compared to large companies, which usually control a bigger part of the entire product life cycle.)

So cooperative cleaner production projects in SME rarely lead to revolutionary improvements in the eco-efficiency of the companies involved but rather to incremental progress. Nevertheless, due to multiplicative effects, cleaner production may contribute considerably to improve the material and energy efficiency of European economies. The cooperative cleaner production approach does have a considerable although not overwhelming potential to contribute to sustainable development.

Economy of cleaner production

The ECOPROFIT project has shown that cleaner production projects can reduce companies' total costs by 1 – 1.5 % by investments made according to the companies' own investment standards. This correlates well with the findings of the Deutsche Bundesumweltstiftung. However, not all cleaner production measures reduce costs. Required investments, higher labour intensity, substitution of more expensive (but environmentally less harmful) materials or energy-carriers or necessary research and development may bring additional costs that outweigh savings in energy and raw-materials. A relative increase of raw-material and energy costs compared to other production factors (e.g. by tax reform) would logically give more importance to cost reductions by energy or material savings. Due to accounting and valuation problems it is sometimes difficult for companies to quantify the financial effects of cleaner production measures. Uncertainty and risks are often a hurdle to cleaner production investments. So to get a better basis for investment decisions, methodologies would have to be clarified and data availability improved.

Most companies participating in the ECOPROFIT and PREPARE projects believe that the projects have increased their competitiveness Motivation and satisfaction of employees has improved significantly. Direct effects on employment can generally be neglected.

Conclusions

Cooperative cleaner production projects improve the eco-efficiency of processes and companies and can at the same time reduce costs, thus leading to an improvement in competitiveness. It is desirable that cleaner production find broad resonance in industry, especially also in SMEs. Despite the inherent positive ecological, economic and financial effects, an economy-wide implementation of cleaner production in SMEs requires additional measures in order to be successful. More political commitment to promote cleaner production solutions instead of end-of pipe technology would give an important stimulus. An ecological tax reform which increases the relative costs of raw-materials and energy, in comparison to other cost factors such as labour, would clearly be beneficial. Laws regulating the concession of operating permits to companies could demand the adoption of cleaner production more explicitly. In this context the definition of BAT (best available technologies) should put a strong emphasis on preventive environmental protection approaches. Information campaigns promoting the advantages of cleaner production could provide the background for a positive response of companies to preventive environmental protection options. Findings and results of cooperative cleaner production projects should be disseminated to the relevant industries using various communication tools.

Transfer of knowledge on cleaner production from universities and consultants to companies and between companies could be improved. The diffusion of identified cleaner production options within a sector and between sectors should be enhanced. Many cleaner production solutions (such as improved energy efficiency) can be applied to companies in different industrial sectors. Cooperative cleaner production projects have identified a number of technological bottlenecks for improving eco-efficiency. For example in waste water reprocessing and recycling many specific problems need to be researched. Cooperation between industry and universities in this field should be stimulated. Specific research programmes may be set up drawing from the experience of cooperative cleaner production projects.

The integration of cleaner production and environmental management systems promises synergies. EMAS and ISO 14001 are mainly focused on the auditing of the management system. The standards and the regulations do not provide the organization with explicit tools how to understand and measure its waste, discharges and emissions. Without a regular analysis of the flows of energy and materials caused by a company it has no real picture of its environmental relevance. Tools developed in cooperative cleaner production projects can help to close this gap. On the other hand, an environmental management system integrating the implementation of cleaner production strategies can cause a cleaner production project to develop in such a way that it moves towards a continuous improvement process, decreasing the environmental effects of an organization by

To the extent that energy and raw-materials costs increase cleaner production will become more competitive

Despite the inherent positive ecological, economic and financial effects, an economy-wide implementation of cleaner production in SMEs requires additional measures in order to be successful

Measures could include improved knowledge transfer and the development of analytical tools to support environmental management improving eco-efficiency. So legislation and regulations should try to integrate the cleaner production and Environmental Management approaches.

There seems to be a consensus that sustainable development requires a considerable increase in eco-efficiency of production, or in other words, a decrease in material and energy intensity. There are concepts such as Factor 4 or Factor 10, which estimate the necessary reduction of raw-materials and energy use to achieve a certain product or service to be 75 % or 90 %, respectively. If we contrast this to the typical achievements of cooperative cleaner production projects, it becomes obvious that they clearly represent a move in the right direction. Nevertheless, sustainable development will require even more profound innovation with more drastic reductions in material and energy efficiency. It seems that function innovation with a radical restructuring of the system of production is crucial to achieving production compatible with sustainable development.

About the authors

Peter Eder is a biochemist with a PhD in chemical engineering from Graz University of Technology, he is working at the IPTS on issues concerning sustainable technologies. He has experience as a consultant on cleaner production and environmental legislation, and has carried out research on sustainability indicators, and worked for a year on a technical cooperation project (bio-diesel programme) in Managua, Nicaragua.

Johannes Fresner is a chemical engineer, holding a degree from Graz University of Technology. He has been working in Cleaner Production since 1992 and in Environmental management since 1995. He is currently working as a consultant, trainer and researcher in the field and is a partner in the company Stenum GmbH.

Keywords

cleaner production, SME, eco-efficiency, cooperative

Note

1- Chemical Oxygen Demand.

References

- Weterings, R., Kuijper, J., Smeets, E., Annokkee, G.J., Minne, B., *81 Options: Technology for Sustainable Development,* Ministry of Housing, Spatial Planning and the Environment, The Netherlands, 1997.
- Gee, D., *Clean production - from industrial dinosaur to eco-efficiency,* Manufacturing Science Finance, 1995.
- Nielsen, B., *Waste Management: Clean Technologies, an update on the situation in EU member states,* Rendan/Krüger/TME Report, prepared for the commission of the European Union, DG XI, 1994.
- Ökoprofit-Steiermark-Prepare, *Initiative für innovatives und umweltbewußtes Wirtschaften, Land Steiermark,* Rechtsabteilung 3.
- Ulhøi, J.P., *Industry and the environment: a case study of cleaner technologies in selected European countries,* 1997.
- Word Business Council for Sustainable Development, UNEP, *Eco-Efficiency and Cleaner Production - Charting the Course to Sustainability.*

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Consensus-Based Approaches to the Development of Sustainable Industry

Celia Greaves, *CEST*

Issue: Many types of organizations are increasingly realising the value of active engagement with various groupings of stakeholders as they seek to improve their environmental performance. Both regulators and the regulated can benefit from a shift away from the traditional industrial stance of 'decide, announce, defend' to one based around informed debate. Potential advantages include greater flexibility in achieving environmental objectives, better environmental solutions and improved cost-effectiveness leading to enhanced competitiveness. These need to be balanced against a variety of practical challenges to effective consensus-based approaches, and these need to be recognized and overcome, if the benefits are to be fully realized.

Relevance: New approaches aimed at achieving a sustainable industry across Europe will have the greatest potential for success where they can be developed within the context of an appropriate and supportive policy and regulatory framework. Such a framework is most likely to be characterized by elements which encourage positive dialogue between industry, regulators and other stakeholders. As new industrial paradigms evolve, policy makers will be best placed to encourage progress towards sustainability where the relationship with industry allows for consensus based decision making, which brings clear benefits to all parties.

Better dialogue - better environmental solutions?

In recent times, there has been a growing interest in a more consensual approach to environmental management. This has been stimulated, in part, by the development of a number of new concepts, such as 'best practical environmental option', which provide scope for flexibility and recognize that there is usually more than one acceptable solution which balances cost, safety, technological considerations and practicality. In parallel with this, the communications revolution and increasing scrutinising powers of the media have meant that it is no longer possible, or appropriate, for companies to operate in a communication vacuum.

The types of organizations which could fruitfully engage in dialogue as a means of working towards sustainable industry are numerous and varied. Depending on individual circumstances, and the aims of the dialogue process, they could include companies, regulators, NGO's, employees, trade associations and local communities. There are, however, a number of generic issues to be considered by any group involved in the process. First, and perhaps

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Engagement between stakeholders requires a willingness to share information openly, moreover, the limits and purpose of the dialogue need to be fully understood by all those involved from the outset

The flexibility of voluntary agreements makes them an increasingly attractive alternative to ever more complex regulation

most importantly, there is the question of risk. Engagement between stakeholders requires a willingness to share information openly, and evidence that the process has an intrinsic value beyond public relations. All parties need to be clear as to their aspirations for the dialogue, and the limits beyond which they are not prepared to extend themselves. A second major concern is the scope of the engagement. The boundaries of the dialogue, as well as its purpose, need to be fully understood by all those involved, and it is prudent to decide exactly who is to be included in the discussions from the outset. For example, under what conditions would it not be appropriate for discussions between a regulator and a company on environmental performance to be extended to the local community in which the company operates? The method of engagement between the parties (open fora, mail questionnaires, focused meetings, etc.) also need to be carefully considered.

There are a variety of situations where a consensus based approach might be appropriate. Some examples are presented in Box 1.

Of particular interest to the policy maker is the scope for consensus based approaches to improve industrial environmental performance in areas such as emissions and waste. Here, initiatives based around voluntary agreements are receiving increasing attention.

A future for voluntary agreements?

The term voluntary agreements attempts to capture the idea that environmental goals and/or instruments of implementation are agreed with the companies to be regulated in such a way as to provide a degree of flexibility of response amongst those affected (Hansen, 1996). With the trend towards globalization, and the growing complexity of regulation (both in terms of design and implementation), such approaches are becoming increasingly attractive as an environmental management tool. In 1996, there were over 300 voluntary agreements recognized by national authorities (EEA, 1997).

In many countries, environmental legislation has developed over a number of years, and may be characterized by a variety of instruments often with only a limited degree of connection and continuity between them. This presents particular challenges to companies seeking to carry out their activities whilst ensuring full compliance with all relevant environmental controls. Voluntary agreements have the potential to play an important

Box 1. Use of consensus based approaches

- **Corporate policy** - where a company might wish to engage with the full range of stakeholders as it develops its response to a specific environmental issue (e.g. the Brent Spar case).
- **Corporate strategy** - particularly in the context of the involvement of stakeholders in developing Corporate Environmental Reports. Companies such as IBM have been at the forefront of efforts in this area.
- **Area-based strategies** - applying consensus tools to initiatives covered by Local Agenda 21 - adopted by various local authorities.
- **Local issues** - companies working with local communities on site specific environmental issues.
- **Regulatory compliance** - providing opportunities for the development of more flexible approaches to the achievement of environmental targets and objectives.

role in providing a clearer way to environmental protection which achieves the required objectives. Against this background, they can also help to foster a proactive approach in industry.

Some voluntary agreements have been developed to provide industry with the opportunity of proving its ability to respond to a particular environmental concern in advance of, or as an alternative to, possible new legislation in that area. Here, the prospect of legislation often provides a significant incentive for industry to consider voluntary agreements as an alternative strategy. For public authorities, this is consistent with de-regulation strategies. An example is the agreement on the use of HFCs established in the UK in 1996. Alternatively, governments may forgo enforcement of existing regulations across companies which are signatories to voluntary agreements.

At the wider level, voluntary agreements which are transparent and accessible to the public help to improve public awareness of the issues involved in achieving a balance between environmental quality and industrial competitiveness (although, of course, there are many instances where the two are not mutually exclusive).

Perhaps the best known European example of voluntary agreements is the 'Covenant' approach adopted in the Netherlands. Here, the government offers industries responsible for particular environmental problems ('target groups') a choice over the way in which they are regulated. The first option is to pursue a traditional, command and control approach, and the second is to enter into a covenant. A covenant is a civil contract which allows an industry to adopt a combination of technological, economic and planning instruments to achieve the interim goals and measures used to ensure that government targets are reached. Results, which could, for example, relate to a defined reduction in emissions, are required by a pre-specified deadline. This is typically the year 2000.

From industry's perspective, a major attraction of the covenant approach is the flexibility to select the most cost-effective mix of measures to achieve the desired outcome. Furthermore, the longer term perspective means that environmental modifications can be integrated into overall business planning processes.

Because of the long time scales attached to covenants, it is not yet possible to provide an accurate picture of the impact on either environmental quality or competitiveness. However, a number of practical concerns have been raised as the process has developed. These cover issues such as uncertainties about the juridical status of covenants and the role of regional authorities, the economic and technical feasibility of the achievement of specific targets and the reaching of agreement on emission levels in reference years (Schrama, 1997). Notwithstanding these concerns, the perceived benefit of this type of approach is clearly reflected in the number of covenants which now exist. There are currently in excess of one hundred covenants in force, covering a range of diverse areas (see Table 1).

Against the backdrop of a sectoral covenant, individual companies are free to create their own environmental plans, which are reviewed to ensure that the aggregates across the sector are sufficient to reach agreed goals. Once a plan has been approved, the company concerned is exempt from other regulations in that area. In some cases, such as energy, the government is providing financial assistance for research and development to support efforts towards the achievement of covenant goals.

In the US, Project XL (eXcellence and Leadership) is a national initiative that allows for the testing of innovative ways of achieving more cost-effective

The prospect of legislation often provides a significant incentive for industry to consider voluntary agreements as an alternative strategy

Perhaps the best known European example of voluntary agreements is the 'Covenant' approach adopted in the Netherlands. This involves a civil contract which allows an industry to adopt a combination of measures in order to meet targets set by government

Table 1. Examples of Covenants in force in The Netherlands

Sector	Characteristics
PRIMARY METALS	A joint covenant between the industry's trade association, individual companies and local, regional and central government to address specific environmental impacts.
PACKAGING	An agreement to reduce volume by 10% (from 1990), and achieve a recycling rate of at least 60%, by 2000.
ENERGY	Cross-sectoral covenants to achieve reductions of around 20% in CO_2 emissions by 2000 (signed up to by over 60% of major industrial sectors).

Project XL (eXcellence and Leadership) is a US initiative to allow innovative ways of achieving more cost-effective public health and environmental protection to be tested

public health and environmental protection. The project is in its early stages, but it is hoped that the lessons learned will be used by Government to assist in redesigning current regulatory and policy setting approaches. A key objective is to trial cleaner, cheaper and smarter ways to achieve environmental results superior to those achieved under current legislation, in conjunction with greater accountability to stakeholders (EPA 1, 1998). Regulatory flexibility is recognized as one way in which this can be achieved, with the mechanisms to be employed being identified on a case-by-case basis. Possible examples include site specific rules, alternative permits and waver policies.

To date, seven pilot projects have been implemented. In each case, there is an emphasis on new ideas which have the potential for wide application. Table 2 summarizes some of the principle elements.

Consensus-based approaches should not be viewed as a substitute for regulation, but rather as an additional management tool for policy makers

Policy issues

Whatever form consensus-based approaches take, it is generally acknowledged that they are not an alternative to conventional regulation. Rather, they should be viewed as an additional management tool for policy makers, which is complementary to traditional approaches.

As mentioned earlier, there are risks for all parties involved in the types of dialogues that are necessary for consensus to be achieved. The various stakeholders need to be willing to engage in open and honest exchange of views and information. This approach is in marked contrast to the adversarial situation which has prevailed in many societies, and the level of co-operation required may be a major challenge. Progress is most likely to be achieved where there· is a 'culture of dialogue'. There are interesting parallels here with societies' approaches to labour relations (e.g. strikes vs negotiated settlements).

A key success factor for voluntary agreements is the balance of the attractions for the regulator (potential for more vigorous/cost-effective environmental protection) against those for industry (consistent, long-term policies and greater flexibility in compliance). Regulators also need to be satisfied that their role in ensuring that there is uniformity in the decision-making process is not compromised. Thus, it is important that voluntary agreements are entered into on a consistent basis. If related agreements are seen to contradict each other or are non-logical, the credibility of the approach will be seriously undermined.

Table 2. Project XL: Summary of current Pilot Projects (EPA 2, 1998)

Location	Key features	Anticipated benefits
Weyerhauser Flint River Operations, Georgia	- minimal impact goal - 15 year time-frame	Environmental improvements already achieved include a reduction in solid waste by 40% and a decrease in air emissions by 13%. Operating costs have been reduced by $176,000 and savings in future capital spending are expected to amount to $10m. Long term environmental benefits include a 50% cut in bleach plant effluent and a reduction in water use of 1 million gallons per day.
Intel, Arizona	- facility wide performance based cap on air emissions in lieu of pre-construction permit reviews (individual limits)	By eliminating 30-50 permit reviews per year, Intel is avoiding millions of dollars' worth of production delays. Expected environmental benefits include reductions of up to 60% and 70% across solid waste and non-hazardous chemical waste respectively.
Jack M. Berry Inc., Florida	- aiming to consolidate separate environmental permits into a single comprehensive operating permit	During the first year, several hazardous waste streams were eliminated. The company intends to further reduce the number solvents and lubricants used on site, and replace them with more environmentally friendly materials.
Hadco Corporation, various locations	- seeking to demonstrate whether valuable materials can be reclaimed on site from waste streams - may show how new regulatory approaches can support recycling	On site recycling should help to eliminate transport and third party reprocessing costs. All cost savings are being targeted towards expanded recovery activity and pollution prevention.
Marck Stonewall Plant, Virginia	- determining whether a site-wide cap on specific air pollutants provides better overall air quality, whilst offering enhanced operational flexibility	Reductions in atmospheric emissions of up to around 60% are expected for sulphur dioxide, nitrogen oxide and hazardous pollutants. The company is benefiting from greater flexibility in how it achieves improved environmental performance.
Vandenberg Air Force Base, California	- achieving emission reductions through upgrading of equipment	Annual emissions of ozone precursors are expected to fall by at least 10 tons over the next five years.
OSi Specialities Inc., West Virginia	- methanol re-use/recycling - upgrading of air pollution control equipment in advance of anticipated regulatory requirements	98% of organic compounds will be eliminated from the waste stream. 220,000 kg of methanol will be recovered and re-used per year.

Voluntary agreements have to be entered into in a consistent way and objectives must be clearly defined before dialogue is commenced

Uniformity is easier to achieve if dialogue is held with a single industry representative, but this approach is not possible for all sectors

Thinking on voluntary agreements also needs to follow trends away from considering components of the production-consumption chain in isolation and take a wider view

A critical prerequisite for successful voluntary agreements is clear objectives which have been determined through a process of consultation between government, industry and other key players. Success can be compromised if the outcomes of the agreement are uncertain.

The examples given above are largely concerned with agreements between national governments and industry sectors. A particular challenge here is ensuring the coverage of the settlement. Success could be undermined where the sector of industry under consideration is unable to coalesce around a central body. A consistent approach to an environmental issue may well not be achievable unless the regulator can establish dialogue with a single voice. However, this does depend on individual circumstances and the aim of the agreement. For example, where a single company has a significant environmental impact through its activities it may be possible to enter into a one-to-one agreement. It needs to borne in mind that the greater the fragmentation of this approach, the more time and resource intensive it tends to become.

The Dutch approach is based around the concept of target groups of industry, which have been selected on the basis of their contribution to the national environmental pollution burden. A criticism of the strategy is that is disregards the complex interdependencies of different branches of industry and companies operating along the supply chain (Schrama, 1997). In line with other thinking on environmental management, which is moving away from a focus on individual components of production to examine opportunities for efficiency along the production chain, there may well be benefit in taking a wider perspective the application of voluntary agreements.

Voluntary agreements raise issues of subsidiarity. For European Union member states, it is necessary to be able to demonstrate that the outcomes of such initiatives are in line with overall European requirements. Conversely, if voluntary agreements are to make a significant contribution to sustainable industry, European legislation needs to be structured so as to provide scope for these more flexible approaches to be implemented.

Voluntary agreements need to be established with the support of a strong regulatory framework, which allows for rigorous enforcement and clear and effective action against violators. Monitoring and control are equally important, particularly if lessons are to be learnt from earlier experiences. This point was highlighted in a recent study by the European Environment Agency (EEA, 1997) which found that, although there is qualitative evidence to suggest that voluntary agreements bring benefits in areas such as consensus building and awareness raising, a lack of monitoring and reporting in existing agreements prevents the establishment of a causal relationship between observed environmental improvement and the agreements.

Conclusions

Consensus based approaches represent an important new phenomenon in environmental management, and could play a key role in the development of sustainable industry. They are widely applicable and, depending on specific circumstances, can bring clear benefits for all parties.

For the policy maker, voluntary agreements are an interesting manifestation of consensus based approaches. Experience in the Netherlands and the US suggests that they could provide much greater flexibility for industry to develop new and innovative ways of achieving specified levels of environmental improvement.

The practical implementation of participative approaches raises a number of challenges which need to be addressed if success is to be assured. All forms of dialogue require a certain level of openness between both regulator and the regulated if they are to succeed. This represents an important consideration for both sides, with skills in negotiation and recognition that outcomes will inevitably represent a compromise. The process may be facilitated in societies where a 'culture of dialogue' prevails.

Another key issue to be addressed is how enforcement can operate where the agreement is between the regulator and a trade association or similar representative body. The problem of free riders needs to be considered carefully in planning any voluntary agreement.

Experience to date reveals several factors which are likely to influence the likelihood of success through a consensus based approach. These include:

- the balance of benefits to those involved;
- the willingness on all sides to exchange views and information, and reach a compromise;
- extent to which an industrial sector can be represented by a single voice;
- cost and time implications relative to traditional approaches (covering initial negotiations, detailed strategies, enforcement); and
- cultural context - scope for positive dialogue.

Experience of voluntary agreements remains limited, with the majority of those in force yet to prove their worth. As suggested at a recent OECD meeting of Environment Ministers, there is a need for further research into effectiveness. This will help to ensure that future agreements are designed and implemented in such a way as to optimize outcomes for all involved parties (ECO-OECD, 1998).

Notwithstanding the benefits which voluntary agreements and other participative approaches can bring, it is important to remember that they are not always appropriate. Furthermore, they should not be considered as alternatives to traditional forms of regulation, but rather as complementary or additional tools for achieving desired outcomes. Regulators need to be confident that they can achieve the required results where they are introduced.

This Paper has sought to highlight the opportunities presented by consensus based approaches, and to illustrate some of the practical issues which need to be considered if they are to be applied successfully. The aim has been to show that whilst they are not a panacea, such approaches do represent a valid alternative option for policy makers, and can achieve cost effective solutions, which have the potential to both preserve the environment and maintain industrial competitiveness.

Voluntary agreements need to be backed up by a strong regulatory framework and rigorous enforcement

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Keywords

dialogue, consensus, stakeholders, regulation, environment

References

- Department of the Environment, *Voluntary agreements on the use of HFCs between government and industry*, January 1996.
- ECO-OECD, *Report on ECO-OECD Environment Ministers Meeting*, April 1998.
- EEA (European Environment Agency), *Environmental Agreements, Environmental Effectiveness*, Environmental Issues series no. 3, EEA, July 1997.
- EPA 1, *What is Project XL? Excellence and Leadership in Environmental Protection*, United States Environmental Protection Agency, EPA 231-F-97-001, April 1998 (**http://ww.epa.gov/Project XL**).
- EPA 2, *Project XL: Summary of Current Pilot Projects*, United States Environmental Protection Agency, EPA 100-F-98-008, March 1998 (**http://ww.epa.gov/Project XL**).
- Hansen, L.G., *Environmental Regulation through Voluntary Agreements - Complex Regulation Problems*, AKF Forlaget, June 1996.
- Schrama, G.J.I., Centre for Clean Technology and Environmental Policy, University of Twente, *Voluntary Agreements and other incentives for Corporate Environmental Management in the Netherlands*, Presented at Workshop on Voluntary Agreements, Oslo, 15 December, 1997.

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Eco-Industrial Development: The Case of the United States

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Issue: Businesses, local government and community groups are all seeking new answers for how to assure greater compatibility between environmental and economic opportunities. One possible contribution to meeting this challenge is a new phenomenon capturing the imagination of those concerned with responsible economic development in the United States. This phenomenon is known by various names, grouped here under the rubric of eco-industrial development[1]. Eco-industrial development represents a systematic effort among a network of businesses and potentially other organizations to consciously work collaboratively to achieve continuous improvements in economic and environmental performance.

Relevance: The President's Council for Sustainable Development (PCSD), various U.S. Federal agencies such as the Department of Energy, Environmental Protection Agency, National Oceanographic and Atmospheric Administration, and Economic Development Agency are, among others, giving this fledgling movement a boost. Applications of industrial ecology are being examined as possible routes to increased competitiveness, environmental improvement and employment generation.

Industrial Ecology

Industrial ecology is an emerging framework for viewing the relationship between business and the environment. In 1989, the concept of an industrial ecosystem received wide attention with an article in *Scientific American*. In the publication, two General Motors' researchers suggested that the days of finding an 'open space beyond the village gates' for industrial by-products were quickly fading and new ways of thinking about wastes and pollution were needed (Frosch and Gallopoulos, 1989, p. 144). Since that time, the concept of industrial ecology has spawned an increasing amount of research, discussion, and actual implementation. At the most basic level, industrial ecology describes a system where one firm's wastes (outputs) become another's raw materials (inputs). Within this 'closed loop' fewer materials would be wasted.

The time when industry could simply dump its waste is coming to an end. Industrial ecology, in which one firm's waste is another's raw material, is an interesting approach to the problem

Kalundborg, Denmark: The Model Industrial Ecosystem

A unique industrial ecosystem has been slowly evolving in Kalundborg, Denmark and has become a favourite example for industrial ecology enthusiasts. Located roughly 75 miles east of Copenhagen, Kalundborg is a small industrial area on the Danish coast. The industrial symbiosis began to evolve in the 1970s, as several of the core partners, trying to reduce costs and meet regulatory goals, sought innovative ways of managing waste materials and using freshwater more efficiently. The partners making up the Kalundborg system include, among others:

- *Asnaes Power Station*—Commissioned in 1959, the coal-fired plant boasts a 1,500 MWe capacity. The same company also operates a fish farm.
- *Statoil Refinery*—One of Denmark's largest refineries with a capacity of between 3-4 million tons/year.
- *Gyproc*—Manufactures gypsum-based wallboard.
- *Novo Nordisk*—Produces a significant amount of the world's insulin supply and certain industrial enzymes.
- *City of Kalundborg*—Provides district heating services to the town's residents.
- *Local farmers*—Many hundreds of farms producing a variety of crops are located within the area.

The town of Kalundborg, 75 miles from Copenhagen, is a frequently cited example of this kind of symbiosis

A number of symbiotic connections have developed between major and minor partners. The Statoil refinery distributes sulphur by-products to a sulphuric acid manufacturer and hot water to local greenhouses. Waste heat and steam from the Asnaes Power Station are used by Novo Nordisk, which in turn distributes organic sludge from its manufacturing process to local farmers for fertilizer. The Kalundborg model goes beyond material exchanges in a limited way to other types of collaborations in worker training and worker safety (Gertler, 1995). However, the primary focus has remained on the material and energy exchanges. Figure 1 sketches the symbiotic relationships between the core partners of Kalundborg and others that operate within the system.

Energy and waste exchanges were originally designed to find financially rewarding uses for waste materials or unused energy. Over time, however, business managers discovered that significant environmental benefits were also resulting from the innovative system of exchanges (see below).

Box 1. Kalundborg environmental benefits

Kalundborg Environmental Savings Per Year

Reduced Resource Consumption
- Oil 19,000 tons
- Coal 30,000 tons
- Water 600,000 cubic meters

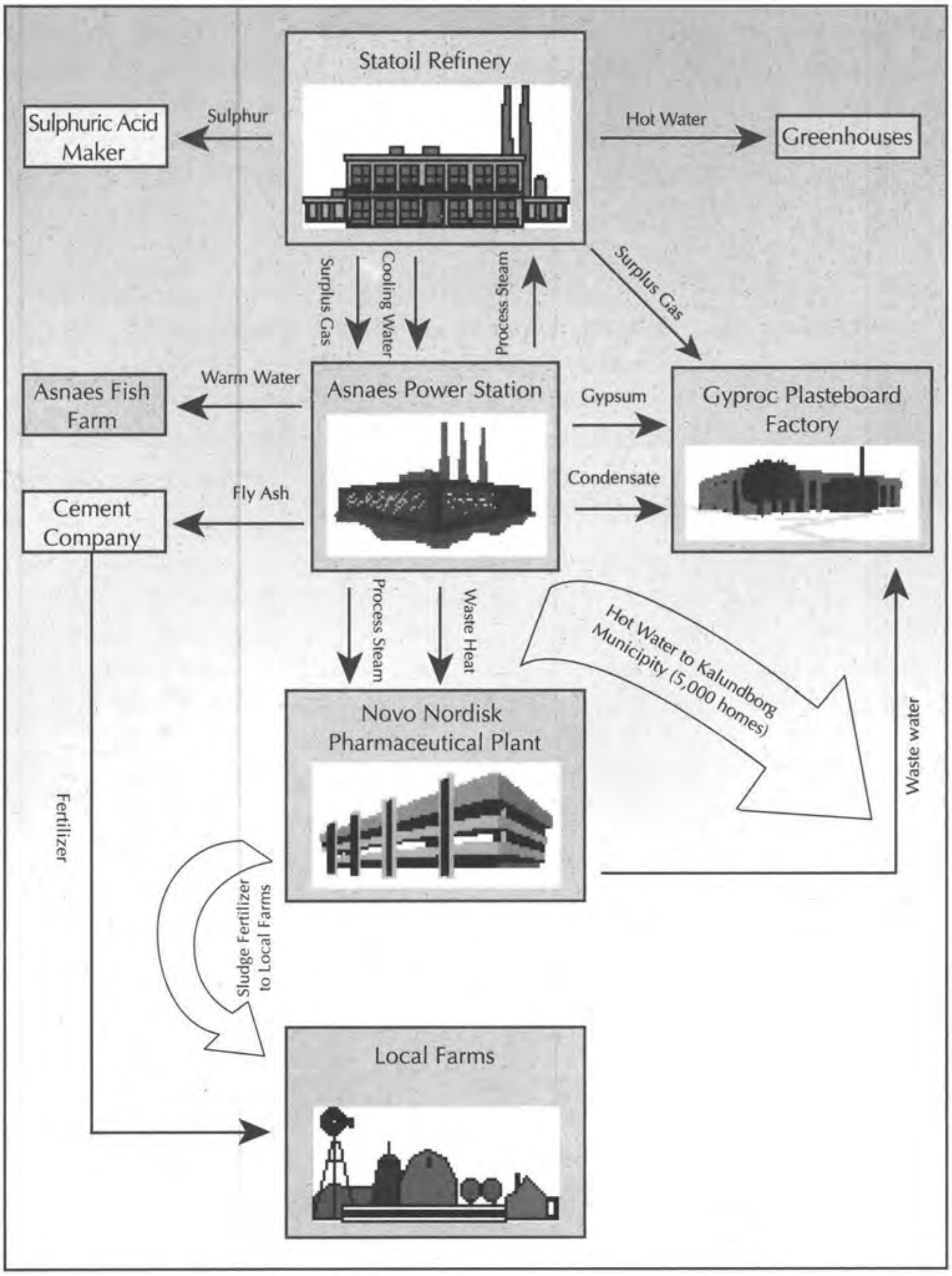
Reduced Emissions
- CO_2 130,000 tons
- SO_2 3,700 tons

Reuse of Waste Products
- Fly Ash 135 tons
- Sulphur 2,800 tons
- Gypsum 80,000 tons
- Nitrogen in sludge 800,000 tons

According to Jorgen Christensen several principles assisted the symbiosis in Kalundborg:

- the industries fit together;
- the geographical distance was not too large;
- the 'mental distance' between participants was short (they all knew each other);
- the incentive was a sustainable economy with commercially sound agreements;
- cooperation was voluntary but conducted in close collaboration with regulatory authorities (Christensen, 1994).

Figure 1. Kalundborg Industrial Symbiosis



Although a useful example of what is possible, the long period Kalundborg took to develop has encouraged others (particularly in the US) to look for a more proactive approach

In the U.S. a number of different approaches are being applied in an effort to create inter-firm collaborations for improving system-wide environmental and economic performance

American efforts view Kalundborg as a touchstone for what is possible. There are several projects in the U.S. such as the Mississippi Ecoplex, Chattanooga Smart Park, and Londonderry New Hampshire that have used the central energy flow or the sharing of steam and water resources as a core anchor for their activities. Yet Kalundborg appears to have been a result of small town connections with little systematic review or management of the system. It has a focus more on economic and environmental synergy, but beyond the town's use of the slogan of 'industrial symbiosis' the connections have not been a major catalyst for industrial recruitment. It appears to have a larger number than usual of energy and material connections, but these seem to be an accretion of useful links rather than a result of a broader strategic focus or systematic review of possible beneficial inter-connections. Americans are also impatient with a two decade evolution as a satisfactory process to emulate. The American response has largely been to look to the Danish example as illustrative but seek more proactive ways to model and imagine eco-industrial possibilities.

By-product exchanges and recycling are not new ideas. Many different industries including metals, paper, wood, and plastic use large amounts of recycled materials. Further, niche industries such as used-oil recycling, fly ash for concrete production, and organic solid waste composting for soil enhancements have developed in many countries. Firms such as International Business Machines (IBM), Xerox, Minnesota Mining and Manufacturing (3M), and many others engage in 'investment recovery' to identify and re-deploy excess raw materials, obsolete products; excess or older machinery; and potentially valuable waste materials. IBM operates a 'de-materialization' centre that recycles or reuses materials from the company's many distribution outlets. 3M's 'Pollution Prevention Pays' (3P) programme has saved the company millions of dollars.

Can Eco-Industrial Development Be Facilitated?

Ernest Lowe asks this very question and offers a qualified yet encouraging response:
"There are as yet few data on the feasibility of deliberately creating a network of companies utilizing each other's energy and materials by-products... Kalundborg, Styria, and petrochemical complexes like the Houston Ship Channel, developed spontaneously, not as the result of policies and strategies based on industrial ecology. However there are strong precedents for companies locating in parks or regions where they will be near suppliers or customers, and in fact this is one of the rationales for industrial parks" (Lowe, 1997, p. 58).

In its earliest stages in the United States, eco-industrial thinking revolved around recreating Kalundborg. Paul Hawken notes in *The Ecology of Commerce*: 'Imagine what a team of designers could come up with if they were to start from scratch, locating and specifying industries and factories that had potentially synergistic and symbiotic relationships' (1993, p. 63). In the U.S. a number of different approaches are being applied in an effort to create inter-firm collaborations for improving system-wide environmental and economic performance.

Some dominant features of the various projects are described below.

Specific parcels of land: The Green Institute in Minnesota is a 6 acre site with a new building scheduled to open by February 1999, but is already over 80% pre-leased. The project is forming a network of businesses in the Phillips neighbourhood with a clearly connected set of values and close proximity. Other projects focused on specific parcels of land include a preliminary concept for Denver, Colorado's Stapleton Airport, a remanufacturing effort in East St. Louis, Missouri, and an ambitious project, 'Mesa del Sol,' outside of Albuquerque, New Mexico that seeks to change the development paradigm of 25% of the city's land area.

Virtual eco-parks: In Brownsville Texas, with the assistance of the Bechtel Corporation, a detailed computer modelling of regional material and energy flows is being used as way to connect businesses and to aid in the recruitment of others. Other virtual examples include Baltimore, Maryland, and a project in the Research Triangle region of North Carolina.

Environmental Technology: In Cape Charles VA, a Sustainable Technologies Industrial Park aims to recruit firms into flexible manufacturing buildings as part of an integrated effort for economic and community development. Targeted market areas include environmental technologies, as well as value-added agriculture and aquaculture applications. In Civano Arizona, an innovative residential/commercial/industrial mix arose out of a commitment to solar energy and new building materials. In Plattsburgh New York, an ISO 14000 focus is being used as a major part of their recruitment strategy.

Resource/Energy Focused Parks: In Vermont, a biomass power plant's waste heat is being used to speed composting and the growth of organic vegetables with spin-offs to various food related and gardening activities. The Red Hills Mississippi effort is linking a new large clean coal power plant, a lignite mine and associated industries. In Chattanooga, a district energy system for several commercial and industrial customers is a central component of the SMART Park project. An emerging effort in Dallas Texas seeks to create a park around a landfill that would divert and extract resources. In Endicott, NY, IBM is encouraging other companies in the area to network as a way to complement its asset recovery plant and find new uses for recovered materials.

Cluster Analysis: Techniques for Eco-Industrial Development

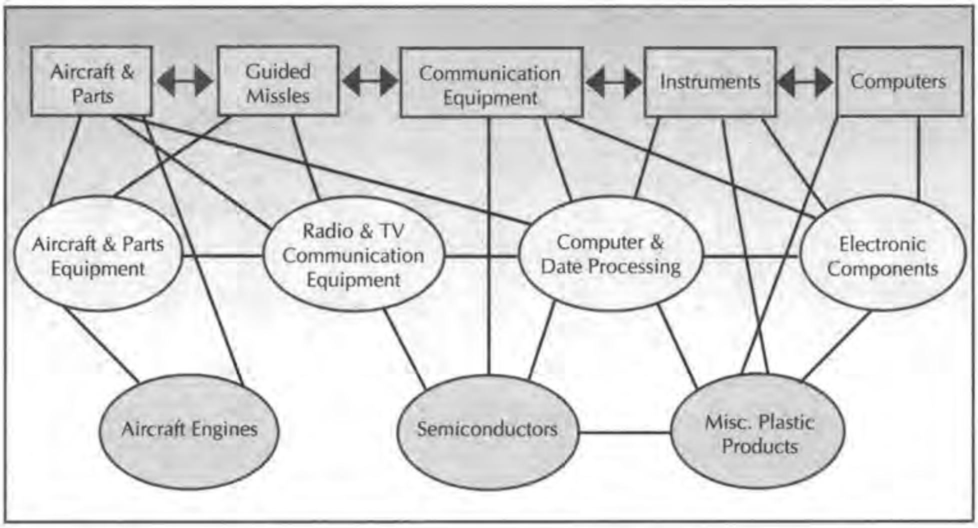
Since Michael Porter's, *The Competitive Advantage of Nations* (1990), economic development officials have turned an intrigued eye towards 'industrial clusters.' According to Porter, industrial clusters are sets of industries connected through customer/supplier relationships, technological areas, labour, or distribution. A few of the more prominent clusters in the U.S. include: high-tech corridors outside Boston and in Silicon Valley; apparel and furniture in North Carolina's Piedmont; and aerospace manufacturing in Seattle and Southern California. Figure 2 below shows a schematic diagram of a cluster of industries in Southern California.

In the U.S., economic development organizations are using cluster analyses in order to target economic development policy for greater success in business retention, expansion, and attraction. Similarly, many eco-industrial development projects have used a variation of cluster analysis as a tool for gaining insight into a number of areas, such as:

- assessing a region's inputs and outputs or its industrial metabolism in order to uncover possible by-product or energy exchanges;
- discovering other collaborative possibilities between existing organizations such as joint environmental permitting, or shared pollution prevention training;
- targeted recruitment of firms that complement the local cluster of firms or can realize strategic advantages from existing infrastructure, institutional connections, market proximity, etc.

Recently, much attention has turned to 'industrial clusters' in which sets of industries located in close proximity to one another are connected through a variety of relationships and networks

Figure 2. Aerospace/Advanced Manufacturing. Cluster in Southern California*



* Figure adapted from Anderson, 1994. See references section for full citation.

In a six county area of North Carolina, the Triangle J Council of Governments is analysing data on water, materials, and energy inputs as well as by-products of the region's industrial base for an industrial ecosystem project. Cornell University's Work and Environment Initiative (WEI) conducted baseline analyses for projects in Baltimore, MD, Trenton, NJ; and Plattsburgh, NY (WEI, 1995; WEI, 1996a, WEI, 1997b). These reports assessed several categories of information about each region including: the current industrial base; institutional support structures such as research institutes; potential market areas; business retention and expansion programs; and targeted recruitment possibilities for new economic development. Similarly, the Green Institute project in Minneapolis distributed a survey to businesses in an area covering 19 postal codes as a means of learning more about local inputs, outputs, and business interest in the concept of eco-industrial development (Lau, 1998).

While good planning efforts can help to better understand the collaborative possibilities of an eco-industrial project, it seems unlikely that this process will produce an array of participating organizations

Other methods of initial analysis have included large group interventions such as design charrettes. In 1995, the Cape Charles community participated in a master planning design charrette that resulted in a visual image for moving forward with the Sustainable Technologies Industrial Park. Similarly, the Green Institute also instituted a design charrette phase as a means of soliciting input from the local community and incorporating their ideas into project planning. Baltimore used a planning charrette as a means to take its strategic focus to the next step.

The symbiotic relationships in Kalundborg emerged over two decades, evolving from a number of bilateral relationships. The challenge for eco-industrial development projects seeking to approach the elegance of Kalundborg is how to encourage collaboration. As one author suggests: *"At Kalundborg, the companies organized themselves through market-based deals... this suggests that parks or regions seeking to recruit companies to form by-product exchange networks must not over-plan"* (Lowe, 1997, p. 59).

While good planning efforts can help to better understand the collaborative possibilities of an eco-industrial project, it seems unlikely that this process will produce an array of participating organizations. Therefore a complimentary component is necessary as a coordinating mechanism for getting the proper people in the room for discussion.

Business Networking

Competition is the defining buzzword of the free market; however, it is also true that businesses frequently find it necessary to cooperate. Strategic partnerships, short-term alliances, and contractual relationships are different types of inter-firm collaborations designed for harnessing a competitive advantage. And increasingly with the globalization of the world economy, maintaining competitive advantage requires flexibility, responsiveness, and adaptability to rapidly changing conditions. Connections along the supplier-producer-customer chain are being tightened.

Private sector organizations are connected in many different types of ways. No company controls all of the resources necessary to achieve success. Manufacturers require inputs from suppliers and products need customers. Corporate/university connections for specific research and development activities are another area of cooperation.

A number of authors have explored various aspects of business networking, strategic alliances, and other forms of inter-organizational cooperation. Alter and Hage (1993) discuss the multiplication of inter-organizational alliances and describe their theoretical antecedents. Chisholm (1998) uses the New Baldwin Corridor Coalition as a case study on the formation and operation of inter-organizational networking. A conference held at the University of New Brunswick formed the basis for a book on 'institutional interventions designed to foster business networks as a tool for regional development' (Staber and Schaefer, 1996).

In the last twenty years, many researchers have discovered the Emilia-Romagna region of Northern Italy, where inter-firm collaboration through flexible manufacturing of various goods occurs, utilizing the specialized expertise of individual firms (OECD, 1996). Firms connected by production and social cooperation have achieved high levels of success:

"In Italy whole industrial districts consisting of thousands of small firms specializing in particular industrial sectors such as ceramic tiles, woollen cloth, and agricultural machinery, have been the backbone of much of Italy's post-War, export-led industrial success. These districts are superior in terms of innovation and market responsiveness through a combination of competition and cooperation, and group-based service centres offering assistance in technology and market intelligence" (Matthews, 1994, p. 178).

Geographically connected firms located in industrial parks or other areas of concentrated business activity are likely to have some type of formal or informal interactions. Whether that is through an industrial park management authority, local manufacturing associations, or a chamber of commerce is highly variable and depends on the availability of local networking infrastructure. Within these types of networks cooperative activities often occur on matters of local, regional, and national interest, such as education, labour, or regulations. One of the most visible and most successful networks in the United States is **Joint Venture: Silicon Valley Network**.

Incorporating the high-tech corridors of Santa Clara, San Mateo, Santa Cruz, and Alameda Counties which make up Silicon Valley, Joint Venture is a not-for-profit organization that features public-private partnerships between companies, community organizations, and local government. By July 1995, 11 initiatives in three primary areas had

As well as competition, cooperation, in the form of strategic partnerships, short-term alliances, and contractual relationships and other types of inter-firm collaborations, is a means of harnessing a competitive advantage

One of the most visible and most successful networks in the United States is Joint Venture: Silicon Valley Network, which features public-private partnerships between companies, community organizations, and local government

Some type of systematic networking framework will be an important key for maintaining viability and collaborative activities within an eco-industrial development project

Eco-industrial networking needs to be built on market relationships if it is to be a success, creating the conditions for eco-industrial networks is more likely succeed than overplanning

been identified as areas of cooperative activity - business climate, business development and entrepreneurship, and social infrastructure and quality of life (Joint Venture, 1995).

Joint Venture is an example of an inter-organizational collaboration that is conscious, aware, and works through institutional channels to accomplish its goals. It is our assumption that within an industrial ecosystem, similar awareness will be required. New levels of collaboration and cooperation could be necessary around different types of issue such as by-product exchanges, shared technical services, worker training, and joint regulatory initiatives.

Some networks around the world are highly developed and include management structures and formal programmes, while others are less tightly knit. Examples of cooperative networking may include research and development (R&D); product manufacturing and assembly; training; purchasing; and marketing. For the participating small and medium sized enterprises, networking provides a means of increasing economies of scale, competing with large integrated conglomerates, lowering costs of doing business, and creating continuously 'learning' organizations. As Richard Hatch stated in testimony before the U.S. Congress, 'networks are quite simply cooperative efforts to escape from the limitations of size' (1989, p. 9).

National and state governments around the world have established programmes to facilitate business networking. The Business Links Programme in Great Britain (Grayson, 1996), and Quebec's clustering and networking public policies (Ferland, Montreuil, and Poulin, 1996) are attempts to realize the benefits of inter-firm cooperation. In the US several states have established programmes to support network development (Lowe, 1997).

Using Networks to Facilitate Eco-Industrial Development

Eco-industrial projects in the US are attempting to shorten the time frame for innovative collaborations between organizations. Beyond initial baseline understandings, some type of systematic networking framework will be an important key for maintaining viability and collaborative activities within an eco-industrial development project.

Further, if the overall goal of an eco-industrial development project is to improve economic and environmental performance across the system, individual focus on by-product and energy exchanges seriously inhibits other potential collaborative opportunities. A more systematic approach may be necessary to consciously frame a wide range of possibilities, across a number of functional and thematic layers. Within key areas familiar to business, numerous possibilities for collaboration might emerge such as joint marketing and green labelling; ride sharing; shared processing equipment; flexible employee assignments; joint purchasing and shared services; and of course materials exchanges and energy cascading. Figure 3 outlines a potential model of collaborative opportunities.

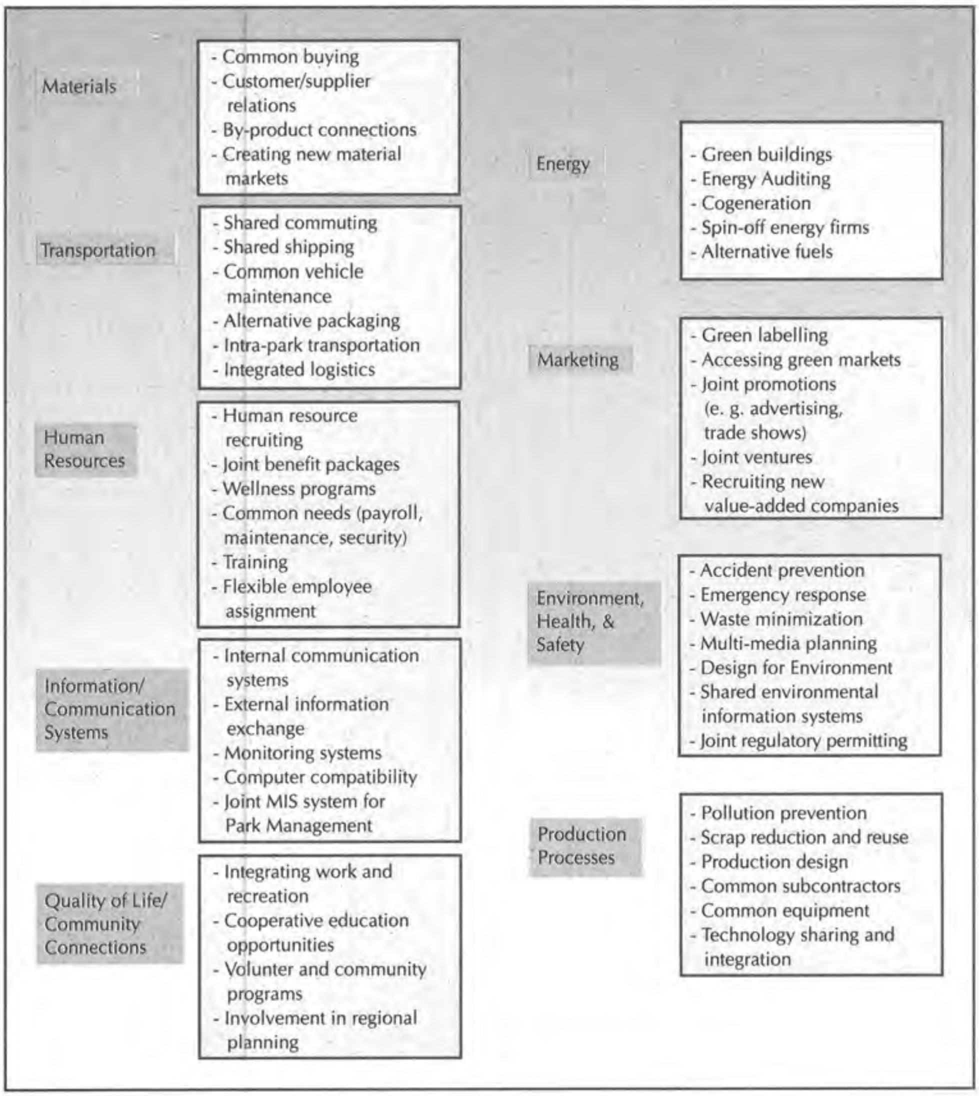
Scepticism about eco-industrial development has centred on the technical and engineering difficulties, coordinating supply and demand needs of participating firms, and regulatory inhibitions (see below). Further, in the United States, there seems to be an expectation that material by-product, and energy exchanges would develop in much more rapid fashion. This impatience has led some to consider eco-industrial development a Quixotic endeavour with little chance of success; however, few projects have fully explored, much less implemented, eco-industrial networking as part of project activities. Moreover, even traditional economic development strategies evolve over years and sometimes decades.

Further, eco-industrial networking strategies can operate on playing fields that business knows best - market relationships. Thus it seems that creating the conditions for eco-industrial development to emerge through facilitated networking strategies is more likely to achieve success in the long run, especially in areas that already have an existing industrial base.

Connecting Policy with Eco-Industrial Development

In many ways, the success of eco-industrial activity is the degree that business sees value and invests their energies into exploring and acting on their mutually beneficial connections. But there is a role for government and policy to play in creating supportive conditions for this to occur. For eco-industrial development, regulatory barriers can preclude by-product exchanges. For example, in the United States, the Resource

Figure 3. A model of collaborative relationships within an industrial ecosystem



Regulations sometimes place obstacles to waste exchange, making it easier to dispose of wastes in landfills than reuse them

One possibility is 'umbrella permits' for eco-industrial development projects as a means of encouraging their formation and lowering the overall impact of industrial activity on the surrounding ecosystem

Conservation and Recovery Act (RCRA) has inhibited inter-firm exchanges of certain types of hazardous materials. While exchanges can occur on a case-by-case basis given the approval of the appropriate regulatory authorities, it is frequently easier to dispose of potential reusable materials in hazardous waste landfills. This is a large waste of money, time and valuable materials.

Paralleling this issue is the increasing focus of regulatory agencies on pollution prevention. The U.S. Pollution Prevention Act of 1990, as well as state-wide efforts across the country are more and more focusing on pollution prevention (P2) for environmental protection. The current focus of eco-industrial development on material exchanges, especially those involving toxic materials, could lock in long term use of those materials, and inhibit P2 or product substitution measures within firms (Lowe, 1997).

Several authors have discussed 'umbrella permits' for eco-industrial development projects as a means of encouraging their formation as well as lowering the overall impact of industrial activity on the surrounding ecosystem. Using multi-media and multi-organizational strategies for permitting might lead to overall, system wide improvements (Cote and Smolenaars, 1997). Similarly, flexibility and voluntary guidelines could encourage firms to seek out innovative ways of meeting system-wide pollution targets. In the United States, the U.S. Environmental Protection Agency initiated Project XL, to encourage innovative yet effective programmes for reducing environmental impacts. The Fairfield Ecological Industrial Park in Baltimore, Maryland applied for and was granted an XL designation.

In keeping with the general theme of this paper, we return to what we view as the key element for success of eco-industrial development. As Boons and Baas have stated:

"In the new concept of industrial ecology, the company boundaries passed through are Environment and Utilities and/or Product Development Alliances between firms... the concept of industrial ecology essentially calls for an integrated approach towards the environmental effects of industrial processes, rather than aiming at the reduction of the effects of separate industrial processes. An implication of this perspective is that the organizations responsible for the processes that are subject to this integrated approach should somehow coordinate their activities" (Boons and Baas, 1997, p. 79).

In the preceding sections we have explored how business networking or inter-organizational collaborations could be a viable strategy for initiating and maintaining eco-industrial development. Further, a number of countries have national and/or sub-national policies or institutional support mechanisms for encouraging business networking among firms. Many of these are focused on competitiveness, market responsiveness, and flexibility. Adjusting these and possibly creating other programmes for encouraging eco-industrial networking could be designed at the national and sub-national levels. Economic development strategy can seek more integrated strategies than industrial sprawl that creates redundant and wasteful use of resources. In an eco-industrial framework, the goal is reduced impact on the eco-system while expanding enterprise capability.

Funding for institutional support such as industrial extension organizations familiar with manufacturing environments or policy incentives can encourage eco-industrial collaborations. Planning for these activities that would attract or grow local business is a critical step. Government support for collaborative data gathering and decision-making would be very helpful. Our belief is that these should lead to commercially viable enterprises that can raise capital on the open market based on increased eco-efficiencies and improved market image as a consequence of their greater environmental responsibility.

The jury is still out on whether eco-industrial approaches will work and will be broadly applicable. Various models are being tested and over the next decade there will be a shakeout based on the lessons learned by its early pioneers. The future requires moving to a new platform of productivity and environmental solutions. The deliberate effort to move beyond enterprise specific solutions as the sole venue of business action to a more resource conscious and adaptive business ecosystem is a harbinger for the future. David Crockett, a councilman in Chattanooga Tennessee and a proponent of sustainable development has commented: 'The choice is between Eco-Industrial Parks or Jurassic Parks'. Organizations of the future cannot afford the slow-witted and resource intensive strategies of the past when the future will demand far greater resource efficiency and market adaptability. Eco-industrial development is one path to that future.

Keywords
industrial ecology, eco-industrial development, interorganizational partnerships, industrial ecosystem, industry clusters, business networking

Note

1- Other terms discussing similar ideas include: eco-industrial parks, eco-parks, industrial ecosystems, zero emissions zones, and industrial symbiosis.

References

- Alter, C. and Hage, J., *Organizations Working Together*. Sage Publications, London, 1993.
- Anderson, G., *Industry Clustering for Economic Development*, Economic Development Review (Spring), p. 37-42, 1994.
- Boons, F.A.A. and Baas, L.W., *Types of Industrial Ecology: The Problem of Coordination*, Journal of Cleaner Production, Vol. 5, p. 79-86, 1997.
- Chisholm, R., *Developing Networking Organizations: Learning from Practice and Theory*, Addison-Wesley, Reading, Massachusetts 1998.
- Cote, R.P. and Smolenaars, T., *Supporting Pillars for Industrial Ecosystems*, Journal of Cleaner Production, Vol. 5, p. 67-74, 1997.
- Frosch, R.A. and Gallopoulos, N.E., *Strategies of Manufacturing*, Scientific American, Vol. 261(3), p. 144-152, 1989.
- Gertler, N., *Industrial Ecosystems: Developing Sustainable Industrial Structures*, Massachusetts Institute of Technology, Boston, 1995.
- Hatch, R., Testimony of C. Richard Hatch, Director, Center for Urban Reindustrialization Studies, New Jersey Institute of Technology, Newark, NJ. *Flexible Manufacturing Networks–Hearing Before the Subcommittee on Regulation and Business Opportunities*. One Hundredth Congress, Second Session (September 13) Washington DC, 1988.
- Hawken, P., *The Ecology of Commerce*. Harper Collins, New York, 1993.

- Joint Venture. *The Joint Venture Way: Lessons For Regional Rejuvenation.* Joint Venture, Silicon Valley Network, San Jose, California, 1995.
- Lau, S., *Eco-Industrial Park Development, Manufacturing Changes: Final Project Report.* The Green Institute, Minneapolis, 1998.
- Lowe, E.A., *Creating By-Product Resource Exchanges: Strategies for Eco-Industrial Parks,* Journal of Cleaner Production, Vol. 5, p. 57-66, 1997.
- Mathews, J., *Catching the Wave,* Allen and Unwin, St. Leonards, Australia, 1994.
- OECD. *Networks of Enterprises and Local Development: Competing and Cooperating in Local Production Systems.* Organization for Economic Cooperation and Development, Paris, 1996.
- Porter, M., *The Competitive Advantage of Nations,* Free Press, New York, 1990.
- Stuber, U.H., Schaefer, N.V. and Sharma, B. (eds.). *Business Networks: Prospects for Regional Development.* Walter de Gruyter, Berlin, 1996.
- WEI. *Fairfield Ecological Industrial Park: Baseline Study,* Cornell University Center for the Environment, Ithaca, New York, 1995.
- WEI. *Plattsburgh Eco-Industrial Park: Baseline Analysis.* Cornell University, Center for the Environment, Ithaca, New York, 1997a.
- WEI. *Trenton Eco-Industrial Complex: Baseline Analysis.* Cornell University, Center for the Environment, Ithaca, New York, 1997b.

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From Products to Services: Selling performance instead of goods

Walter R. Stahel, *Institut de la Durée*

Issue: System innovation focusing on optimizing the performance of a product leading to the replacement of a purchasable good by a service is accompanied by both a significant decrease in material consumption and economic gains. There is an increasing trend among proactive firms to replace products by services as this also brings firms other advantages such as increased customer loyalty and reduced marketing costs.

Relevance: The further development of the products to services transition and the accompanying societal benefits depend strongly on the policies designed to deal with recycling infrastructure on the one hand and the products to service issue on the other.

Introduction

The present industrial economy, which has developed over the last 200 years in today's industrialized countries, is based on the optimization of the production process in order to reduce unit costs and thus overcome the scarcity of goods of all kinds, including food, shelter and durable goods. Emphasis is on more efficient process technologies, and constant improvements in the quality of the goods at the point of sale.

As a consequence, the economies of industrialized countries are today characterized by several key factors:

- Their populations account for only 20% of the world population, but they account for 80% of world resource consumption.
- Their markets for traditional goods, such are automobiles, are saturated. The stock of goods remains fairly constant, and 90% of sales are replacement sales.
- The old remedy of seeking greater economies of scale (centralization of production in order to reduce manufacturing costs) can no longer solve the economic problems, let alone the sustainability issue. For instance, the cost of the services which are instrumental for selling goods produced centrally (production engineering, transport, marketing, insurance, sales commissions) are a multiple of the pure manufacturing costs; a further optimization of production therefore hardly makes economic sense.
- The part of goods that go directly from production to disposal (zero-life products in fig. 1) has reached 30% in some sectors, e.g. agriculture.
- For many goods, desirable results can be obtained paradoxically through system break as well as through the increases in efficiency resulting from product innovation (e.g. the safety gains achieved by traffic jams causing cars to move more slowly are similar to the safety gains provided by air bags).

The emphasis of the economies in today's industrialized countries is mainly on efficient process technologies in order to produce more and better quality products more cheaply

In order to move towards a sustainable paradigm industrialized nations need to unlink indicators of economic success from resource consumption

One approach is for companies that were traditionally considered to be manufacturers to provide a service rather than products

- Incremental technical progress moves more quickly than radical new product development. thus substituting new products for existing ones will increasingly restrain technological progress in comparison to the alternative offered by gradual technological upgrading of existing goods.
- Technological progress is focused on production, not on utilization.

In industrialized countries sustainable development has to start with a considerable reduction of the consumption of resources. Such a 'dematerialization' is only possible through innovation, which needs to be driven by the economy. This then defines a new management task, to unlink economic success from resource consumption, i.e. to produce the same sales turnover and profits with a substantially reduced resource throughput throughout the economy. In many cases, this will only be feasible by redefining corporate strategies, orienting them towards selling performance rather than goods.

The stocks of existing goods therefore represent the new assets to manage - and they constitute a huge stockpile of resources. The main task will increasingly be to reduce the financial burden imposed by the operation and maintenance costs relating to these assets, as is already the case for infrastructures.

Some examples

Several multinational companies have already successfully implemented these new strategies, de-coupling turn-over and profits from resource consumption and manufacturing volume. Schindler elevators is selling carefree vertical transport instead of elevators; Xerox is offering custom-made reproduction services instead of just selling photocopiers; Safety-Kleen and Dow Europe sell the services of chemicals instead of selling chemicals; Safechem and Dow Germany are renting solvents to dry cleaners; Mobil Oil is selling engine oil quality monitoring instead of engine oil (for its 'Mobil 1' synthetic oils); GE Capital and ILFC lease aircraft and Interface Inc. leases nylon carpets. The concept is being considered by many others, including BRAUN, the German household appliance manufacturer. A great number of companies already practice a voluntary buy-back or free take-back system, such as Eastman Kodak and Fuji for their single-use cameras, or GE Medical Systems for medical equipment by any manufacturer.

In most of these cases, the product used to perform the service remains the property of the service company. The product is taken back after use and cleaned or remanufactured prior to reuse. This creates a financial incentive for the company to increase the lifetime of the product delivering the service. The price to pay for success is partly a regionalization of the activities, skills pools and responsibilities of a company. Selling performance also demands success in dealing with regional cultural issues: Ciba-Geigy's strategy of selling yield guarantees instead of pesticides to rice farmers in an African country in the 1980s was a success in eco-efficiency, but not compatible with local power structures.

Traditional examples of service providers selling performance instead of goods are taxi drivers, hotels, railway and ship chartering.

Schindler, GE and other 'manufacturing' companies today generate 75% of their sales volume through services. Their stock market listing (by market capitalization) is normally much higher than their ranking by sales volume, indicating the enthusiasm of investors for dematerialized companies. In areas where manufacturers do not want to accept extended product responsibility, independent remanufacturers have taken over: engine oil re-refiners such as Safety-Kleen, tyre retreaders, companies dismantling goods and reselling second-hand spares, such as Phoenix Technologies in the Netherlands, to name but a few. The number of companies in a country engaged in these activities is normally also a good indicator of the functioning of the market economy!

'The service economy', in the sense used here, is an economy which focuses on the optimization of the utilization (or performance) of goods and services, and thus on the management of existing wealth (goods, knowledge, nature). The economic objective of the service economy is 'to create the highest possible utilization value for the longest possible period of time while consuming as few material resources and as little energy as possible'. Such a service economy is therefore considerably more sustainable, or de-materialized, than the present industrial economy, which is focused on production as a means of creating wealth and on the optimization of the production process in order to achieve economic growth. In contrast to the manufacturing economy, economic success in the sustainable 'asset management' of a service economy does not come from mass production, but from good husbandry and stewardship (Giarini/Stahel, 1993).

Linear economy vs. cyclic economy

The terms 'value added' in exclusive relation to (production) activities up to the point of sale, 'value write-off' (depreciation) after the point of sale, and 'waste' at the end of the first (and only) utilization period of goods, are notions of a linear industrial economy (fig. 1), where the responsibility for goods stops at the factory gate, and where 'waste' – everything that leaves the factory gate – is somebody else's problem (and cost). In contrast to such a linear structure, cycles, circles and loops (fig. 2) have no beginning and no end. The producer's stewardship for his goods is based on a value concept and never stops – an 'economy in loops' thus does not know 'value added' or 'waste' in the linear sense, similarly to natural systems such as the water cycle.

The present national accounting system is a legacy of the linear industrial economy: the fact that waste management, car accidents and de-pollution costs all count as positive contributions to Gross National Product (GNP), on the same level as the manufacturing of goods, shows a basic deficiency of national accounts: GNP is an indication of our economic activity but not an indication of our wealth and well-being. In this reference frame, waste prevention corresponds to a 'loss of income' (i.e. it is economically undesirable); in a sustainable service economy,

The service economy focuses on optimizing performance, getting the greatest possible use out of existing resources, and is clearly a useful starting point for sustainability

This approach transforms the linear paradigm, in which everything which leaves the factory is ultimately waste, to a cyclic one in which the manufacturer is permanently responsible for the management of his output

Figure 1. The linear structure of the industrial economy (or 'river' economy)

▶ zero-life-products ▶

RESOURCE ▶ BASE MATERIALS ▶ MANUFACTURING ▶ P.O.S. ▶ UTILIZATION ▶ WASTE

(Point of Sale)

junction 0: product-life or waste

Source: Stahel, Walter and Reday, Geneviève (1976/1981) Jobs for Tomorrow, the potential for substituting manpower for energy; report to the Commission of the European Communities, Brussels/Vantage Press, N.Y.

Currently used indicators of economic success, such as GNP, can distort the picture and may present waste prevention as a loss of income

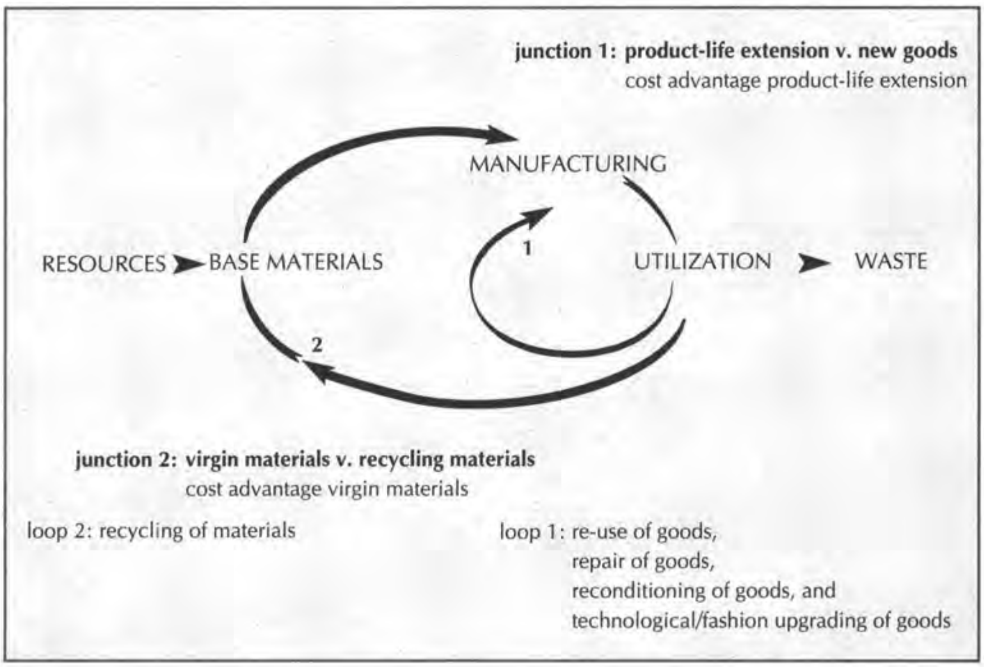
waste prevention is a cost reduction, i.e. a substantial economic saving. The waste management industry in Germany costs the economy about US$ 45 billion p.a. - when the figure goes up, GNP goes up.

When discussing the benefits of the changes towards a more sustainable society, and ways to measure them, it is of importance to keep the fallacy of the current reasoning within the historic reference frame (non-sustainable national accounting system, false prices of resources, subsidies to foster unsustainable development) in mind.

In order to achieve the goal of economic activity based on loops, a number of changes are necessary in the economic thinking and organization:

- The industrial structure for manufacturing and re-manufacturing activities will have to be regionalized in order to be closer to the assets in the market; this means smaller (re-)manufacturing volumes and appropriate methods using more and higher skilled labour, the cost of which is financed through the strongly reduced purchases of materials, and a virtual elimination of disposal costs.
- Products will have to be designed as technical systems based on a strictly modular master plan, with ease of maintenance and ease of out-of-sequence disassembly by workers or robots. The platform concept by Volkswagen is an expression of this.

Figure 2. Closing the material loops: The loops of a self-replenishing, more sustainable service economy (or 'lake' economy), and the junctions between these loops and a linear economy



Source: Stahel, Walter and Reday, Geneviève (1976/1981) Jobs for Tomorrow, the potential for substituting manpower for energy; report to the Commission of the European Communities, Brussels/Vantage Press, N.Y.

Recycling as opposed to services

The service economy and the recycling economy are similar in that they both seek to reduce material flows. However, there are also fundamental differences. Promoting recycling strategies as a way of closing the materials loop (loop 2 in fig. 2) has the short-term advantage that it preserves the existing economic structures (based on material throughput) and so is easy to implement. Ironically, however, recycling becomes less economic as it becomes more widespread. Its very success brings about an increase in the amount of secondary resources, causing oversupply of materials. This depresses the prices of both virgin and recycled resources alike, to which producers tend to react by seeking export markets. Thus overall material flows remain unchanged or indeed are even increased. Future technical innovation in recycling will include improvements in the design for the recyclability of goods, and new recycling technologies, neither of which, unfortunately can overcome the basic price-squeeze phenomenon mentioned (Jackson, Tim, 1993). Increased recycling furthermore does not reduce the flows of material and energy through the economy; it does, however, reduce resource depletion and volumes of waste. In conclusion, recycling is a necessary prerequisite for the service economy, but recycling alone is not sufficient to solve the problem of resource overuse. Recycled materials are more expensive than virgin materials, whereas remanufactured goods are cheaper than new goods: the smaller the loop (in Fig. 2), the higher the competitive advantage!

Strategic outlook

In contrast to recycling, strategies for higher resource efficiency *through optimization of the utilization of goods*, measured as 'resource input per unit of utilization' over long periods of time, will cause substantial structural changes within the economy. The key to this is *closing the product-life extension loop* (loop 1 in fig. 2) which reduces the volume and speed of resources through the economy. This closure can be achieved through the adoption of take-back strategies: because of the inherent structural changes they are more difficult to implement than materials recycling. However, as these strategies are based on innovative corporate approaches, such as the Asset Management Programme by XEROX, they are highly competitive and contribute to sustainable development. They will become even more competitive as this kind of economic activity develops up the learning curve (Stahel, 1994). Future technical innovations that can be expected in this field are technologies enabling the use of re-manufactured and technologically up-graded components and goods, and commercial innovations to keep goods in use as long as possible. (Stahel, 1984).

There is also a non-negligible psychological barrier involved: strategies of a higher resource efficiency often question the validity of the present calculus of economic optimization which ends at the point of sale. At first sight, closed responsibility loops even seem to violate the traditional 'task definition' in the economy (Taylorism): industry produces efficiently and rapidly, consumers consume quickly, the state disposes as cheaply as it can. Strategically, this means that the utilization of goods becomes the centre of economic optimization efforts, instead of production today, and that the utilization value becomes a central notion of economic value (Giarini/Stahel, 1989/1993).

Obstacles, opportunities, trends

The signs are clearly pointing in this direction:

- The trend towards higher resource efficiency and a dematerialization of goods and systems will further increase the economic woes of base material production and the recycling

Although recycling may often reduce resource depletion and volumes of waste, it does not reduce overall flows and does not solve the problem of resource overuse

Remanufacturing strategies are harder to implement than traditional recycling but offer a highly competitive step in a sustainable direction

Governments can play a role in extending manufacturers' product liability, permitting the use of used components in new goods, and focusing research on prevention and precaution rather than processes technologies

sector, as demand and prices of many materials will continue to fall;

- The EU-Directives on product liability, and more recently on product safety, and the draft directive on service liability, all stipulate a ten year liability period, but most manufacturers still give a short term warranty (6 or 12 months);
- Some car manufacturers offer a total cost guarantee over 3 or 5 years, which includes all costs except tyre wear and fuel. Electric cars in California are for rent only;
- The rental of artificial hearts by Baxter and the NASA space shuttle have shown that the re-use of long-life goods can also apply to advanced technology.
- Industry shows an increasing willingness to accept unlimited product responsibility – and to use it aggressively in their marketing - through life-long warranties (which was rejected by a German Federal Court!), money-back guarantees, exchange offers and other forms of voluntary product take-back.
- Out-sourcing is rapidly becoming a generally accepted form of selling results instead of (capital) goods or services. Textile leasing is a strategy that is becoming the norm for uniforms and professional work clothing, hotel linen, hospital textiles (even in sterile operating theatres), towels in up-market lavatories.

Conclusions for policy

The State is the biggest single customer in every economy. Procurement policies of national entities, however, seem to largely ignore the benefits of buying performance instead of goods. Even easy options, such as product-life extension preferences, are hard to impose. The parliament of Baden-Württemberg in Germany was probably the first State world-wide to impose the exclusive purchase of re-refined engine oil and retreaded tyres for all state-owned vehicles, with the exception of some emergency vehicles.

Innovation and an industrial policy for sustainability are the keys to higher resource productivity. The State should define the aim of higher resource productivity (e.g. eco-products) but not the strategies by which it should be achieved. Here again, the European Commission can set standards to overcome national inertia.

Some of the key issues of an industrial policy for sustainability can be summarized as follows:

- Introducing the time factor into the legislation governing the economy.
- Develop and use methods to measure sustainable growth over long periods of time, e.g. GPI (General Progress Indicator, used in the US) or ISEW (Index of Sustainable Economic Welfare) instead of GNP (for a discussion of these indicators see W. van Dieren, 1995).
- Define and legislate the minimum quality of goods for sale depending on their service-life, by requiring a long-life warranty (e.g. in accordance with the 10 years in the EC safety directives), instead of the present exclusion of the utilization of used components in new goods.
- Focus funding on R&D as well as education and training on prevention and precautionary methods instead of process technologies: long-term behaviour of materials, components and goods (wear and tear versus fatigue), technical risk management, industrial design for systems thinking, ways to popularize sustainability in terms of socio-cultural ecology.

The principle of 'insurability of risks' such as insurance as a free market safety net to replace state laws or technical standards would automatically introduce the precautionary principle into the economic mechanisms to choose between possible technologies, present and future. The feasibility of gene technology is a point in case.

Strategies to close the product responsibility loop, such as the voluntary or mandatory take-back of consumer goods, would lead to better products in a more efficient economy (in contrast mandatory recycling leads to better recycling technologies, not better products).

It should be noted that the situation in many Third World countries, however, is radically different. They will continue to experience a strong demand for basic materials for the improvement of their infrastructure, and will continuously suffer from a shortage of affordable resources and goods, including food, shelter, and infrastructure and services for health and education. While a service economy can hardly be a good model for a developing economy (asset management is based on existing stocks of goods), transferring the surplus materials of good quality from industrialized to third World countries may be a solution to the problems of both, if skills and know-how are transferred with the goods.

Summary and conclusions

The trend in the economy towards a more sustainable society and service economy started some time ago, yet many experts are unaware of the potentially fundamental change that may be on the horizon. This is probably due to interpretations in terms of the old industrial economic thinking.

A service society will not solve all problems for society, and especially not the problems inherited from the past (e.g. pollution clean-up, unemployment of over-specialized production workers). Neither will it make the manufacturing sector disappear. But it could well restructure it, into firms manufacturing high volumes of global standardized components, and regional firms specialized on assembly, disassembly and re-manufacturing of products. This is a trend that can already be observed in electronics and aviation technology.

A sustainable economy could be helped by an appropriate structure, characterized by a regionalization of jobs and skills (mini-mills for materials recycling, re-manufacturing workshops for products, decentralized production of services such as insurance), supplemented by centralized design, research and management centres. Such an economy will consume fewer resources and have a higher resource efficiency, its production will be characterized by smaller regionalized units with a higher and more skilled labour input. Transport volumes of material goods will diminish, and be increasingly replaced by transport of immaterial goods (Stahel & Reday, 1976).

Selling performance instead of goods demands a coherent corporate strategy based on the principles of the service economy. This includes asset management, production, marketing, finance and control. It is not possible to apply the controlling yardsticks of the industrial economy to measuring the success of a service, and expect meaningful results. Prevention and sufficiency solutions cannot be measured in terms of productivity.

For the first time since the beginning of the industrial revolution the economy will offer workplace mobility, rather than rely on worker mobility. The more immaterial goods are transported, the higher the feasibility of teleworking. Flexible work organization and part-time work are compatible with, and even a necessity for, providing services and results round the clock.

As services cannot be produced in advance and stored, and mostly have to be delivered at the location of the client, the impact on peripheral zones could be substantial, as could the effect on the environmental burden on central zones (in particular the strain on transport).

The present focus on technology will be replaced by a focus on corporate strategies and

Services tend by their nature to be located closer to the customer than manufacturing. A shift in this direction has major implications for the regional distribution of employment and wealth and implies changes to current working patterns the identification of cultural levers to gain a competitive regional advantage.

Waste management could increasingly become a subject area for historians rather than economists. Many large companies switching to a more sustainable approach have an objective of zero-waste-to-landfill before the year 2000. And some waste management companies are taking over re-manufacturing companies (Safety-Kleen in the U.S.) in a move to become resource managers, instead of 'end of pipe' clean up operators. The best material producers have already become material managers: Du Pont de Nemours is depolymerizing nylon and regenerating polyesters (e.g. PET) cutting the need for oil as main resource.

About the author
Walter R. Stahel is director of the Institut de la Durée in Geneva and a consultant to companies, governments and supranational organizations. His interests include (among others) the managerial and conceptual questions in relation to risk, sustainable development and the shift from products to services. He is author of a number of articles and books on the subject.

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References

- Dieren, W. van, *Taking Nature into account,* Birkhäuser-Verlag, Basel, ISBN 3-7643-5173-X, 1995.
- Giarini, O. and Stahel, W. R., *The Limits to Certainty, facing risks in the new Service Economy*, 2nd ed; Kluwer Academic Publishers, Dordrecht, Boston, London ISBN 0-7923-2167-7, 1989/1993.
- Jackson, T. ed., *Clean Production Strategies, developing preventive environmental management in the industrial economy* - Stockholm Environment Institute. Boca Raton, Ann Arbor, London: Lewis Publishers. ISBN 0-87371-884-4, 1993.
- Stahel, W. R., *The impact of shortening (or lengthening) of life-time of products and production equipment on industrial competitiveness, sustainability and employment* - research report for the European Commission Brussels, DG III. Nov 1, 1994. (commercial in confidence, unpublished).
- Stahel, W. R., *The Utilization-Focused Service Economy: Resource Efficiency and Product-Life Extension.* Pp. 178-190 in The Greening of Industrial Ecosystems, Allenby, Braden R. and Richards, Deanna J. eds. Washington DC: the National Academy of Engineering; National Academy Press, 1994.
- Stahel, W. R., *The Product-Life Factor,* in Orr, Susan Grinton (ed.) An Inquiry into the Nature of Sustainable Societies: The Role of the Private Sector; HARC, The Woodlands, TX, 1984.
- Stahel, W. and Reday, G., *Jobs for Tomorrow, the potential for substituting manpower for energy,* report to the Commission of the European Communities, Brussels/Vantage Press, N.Y, 1976/1981.

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The purpose of this work is to support the decision-maker in the management of change pivotally anchored on S/T developments. In this endeavour IPTS enjoys a dual advantage: being a part of the Commission IPTS shares EU goals and priorities; on the other hand it cherishes its research institute neutrality and distance from the intricacies of actual policy-making. This combination allows the IPTS to build bridges betwen EU undertakings, contributing to and co-ordinating the creation of common knowledge bases at the disposal of all stake-holders. Though the work of the IPTS is mainly addressed to the Commission, it also works with decision-makers in the European Parliament, and agencies and institutions in the Member States.

The Institute's main activities, defined in close cooperation with the decision-maker are:

1. Technology Watch. This activity aims to alert European decision-makers to the social, economic and political consequences of major technological issues and trends. This is achieved through the European Science and Technology Observatory (ESTO), a European-wide network of nationally based organisations. The IPTS is the central node of ESTO, co-ordinating technology watch 'joint ventures' with the aim of better understanding technological change.

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