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## Ecological modernization of industrial society: three strategic elements

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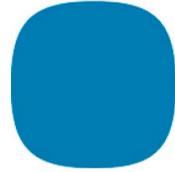
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**Ecological Modernization  
of  
Industrial Society**

**Three Strategic Elements**

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## ABSTRACT

Industrial society is still on a course of conflict with the environment. Natural resources are being over-exploited and the natural ecosystems are over-loaded by non-digestible pollutants. Unchanged, industrial society gives no real chance to nature and provides no future for a sustainable development. Therefore, the time has come for comprehensive industrial restructuring, or "ecological modernization" - a concept, focussing on prevention, innovation, and structural change towards ecologically sound industrial development, and relying on clean technology, recycling and renewable resources.

In this paper, some strategic elements of such a concept are being discussed. Its implementation requires a far-reaching conversion of the economy, a re-orientation of environmental policy, and a re-plenishment of economic policy. To "raise a loan with the ecology," i.e., to better understand nature and to make use of ecological principles, that is what matters now. "Ecological structural change of the economy," "preventive environmental policy", and "ecological orientation of economic policy" seem to be the three main strategic elements to reconcile the interests of man and nature, and to provide for a better harmony between industrial society and the natural environment.

## 1. ECOLOGICAL STRUCTURAL CHANGE OF THE ECONOMY

In both the East and the West, economists, planners and engineers are seeking for a solution to the problem of how to change the traditional patterns of resource use. "Perestroika" and "modernization" are two actual catchwords in this process, and new environmental priorities play a part in the envisaged conversion of the economy.<sup>1</sup> Harmonizing ecology and economy in a specific sense relies on the premise that a reduction in the resource input of production (structural change) will lead to an ex ante reduction of emissions and wastes that have a negative impact on the natural environment (ecological structural change).

In order to clarify the relationship between economic structure and environmental impacts, one needs suitable information concerning the material side of production, for environmental protection and resource conservation by the economy - and thus its long-term sustainability - cannot appropriately be described in such terms as income, investments and consumption. One possibility is to select and compare some indicators describing the environmentally relevant features of the production process. The availability of environmental indicators such as emission data relating to "representative" pollutants - like sulphur dioxide ( $\text{SO}_2$ ), carbon dioxide ( $\text{CO}_2$ ), and nitrogen oxide ( $\text{NO}_x$ ) - has grown recently (e.g., the Annual Reports on the Environment by several industrial nations, by UNEP and the OECD). These indicators concern certain negative environmental effects of production. Less is known on the environmental relevance of the input factors in industrial production, or on the question of which indicators provide environmentally significant information about the structure of the economy. Given the present state of statistics, only a few such indicators can be tested in a cross-national comparison of Eastern and Western countries.

## 1.1 De-linking Economic Growth from Environmentally Relevant Input Factors

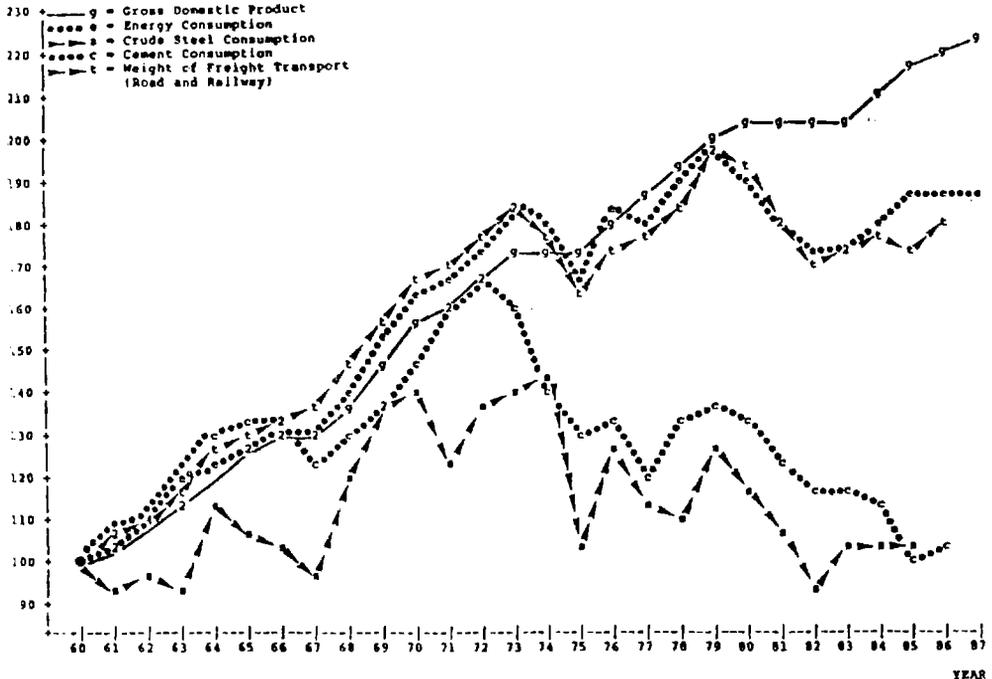
Using a set of four indicators (input factors), Jänicke et al. have studied 31 countries of both COMECON and OECD with regard to the relationship between economic structure and environmental impacts.<sup>2</sup> The four factors whose direct and indirect environmental significance is thought to be self-evident were: *energy, steel, cement, and freight transport*. Regarding their patterns of production and consumption these are environmentally "hard" factors, characteristic of a certain structure of the economy and/or stage of economic development.

The main hypothesis of the research reads like this: Positive environmental effects of structural change of the economy are to be expected by actively de-linking economic growth from the use of environmentally relevant inputs (resources). Such active *de-linking* would

- o result in a decrease of *resource depletion and/or environmental pollution*;
- o mean *ex ante* instead of *ex post* (*end-of-pipe technology*) environmental protection;
- o promote those *integrated technologies* which touch upon several environmental effects (pollutants) at the same time.

Structural change as a shift of input factors to more efficient uses can thus be conceived as a process of *successive de-linking*: The contribution of traditional (hard) input factors to the national product decreases, i.e., they change or lose their function in the development process.

Figure 1: Structural Economic Change in the Federal Republic of Germany, 1960 - 1987 (1960 = 100)



Source: Jänicke et al.

## 1.2 Examples of Marked and Deficient De-linking

Taking the Federal Republic of Germany as an example, *Figure 1* illustrates a five-fold de-linking from the growth of the Gross Domestic Product (GDP): The de-linking of energy and cement consumption and weight of freight transport from the GDP became apparent during the 1970s; regarding steel, the de-linking process began already in the 1960s. In this way, the structural change of the economy generated *environmental gratis effects* of various kinds:

- o The stagnating consumption of primary energy led to a reduction of harmful emissions (pollutants).

- o The relative decline in the *weight of freight transport* indicates that the volume of materials employed was reduced rather than increased.
- o The fall in the use of *cement* represents a direct gratis effect as far as the emissions from cement factories are concerned; this decrease coincided with the trend towards labor-intensive renovation of the housing stock, as compared to new construction.
- o The decrease in *steel consumption* accounts for a considerable reduction in harmful emissions as far as processing is concerned; this drop was strongly marked and partly due to increased recycling activities.

*Environmental gratis effects* occur when the rate of usage of the input factors (resources) having a (strong) negative impact on the environment remains below the growth rate of the GDP. Comparing the rates of usage of the four selected input factors with the growth rate of the GDP, three different development patterns emerge<sup>3</sup>:

- o The factors having impacts on the environment decline absolutely; i.e., *absolute structural improvements* are induced, corresponding to absolute environmental gratis effects.
- o The factors having impacts on the environment remain constant, or increase, but with a lower growth rate than the GDP; i.e., *relative structural improvements*, corresponding to relative environmental gratis effects.
- o The factors having impacts on the environment increase at a higher growth rate than the GDP; i.e., *structural deterioration*, corresponding to absolute negative environmental effects of economic growth.

In *Table 1*, 16 out of the 31 countries studied are grouped according to these three development patterns.

Of all the industrial countries investigated by Jänicke et al., Sweden went through the most rapid structural change. The drastic reduction in cement production (-41%), the decreasing use of crude steel (-38%), and the decrease in the weight of freight transport (-21%) add up to notable environmental gratis effects ("absolute structural improvement").

Table 1: Environmental Impacts deriving from Structural Change - Percentage Changes 1970/1985

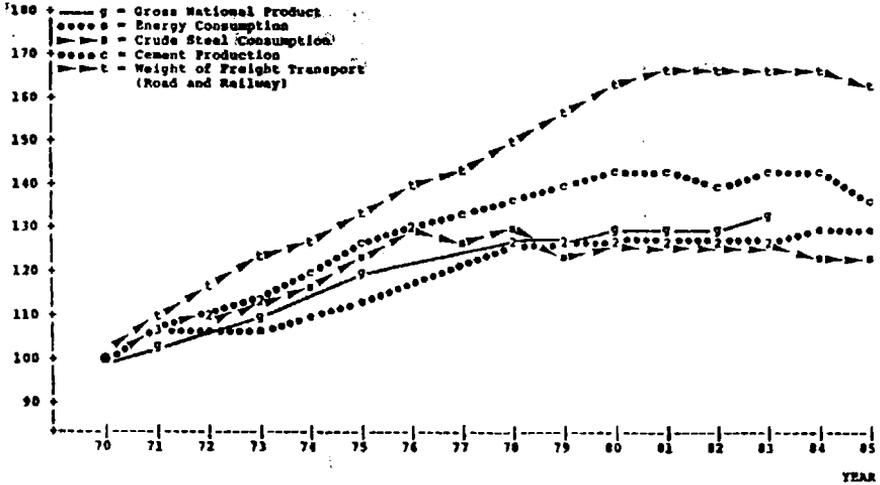
Country	Consumption of		Cement Production	Weight of Freight Transport	GDP *
	Primary Energy	Crude Steel			
<i>Group 1: Absolute Structural Improvement</i>					
Belgium	7.1	-24.5	-17.6	-2.2	42.7
Denmark	-2.7	-15.6	-33.2	20.1	40.8
France	30.3	-34.8	-23.4	-14.5	51.6
FRG	13.4	-26.3	-32.8	4.4	38.4
Sweden	26.4	-37.9	-41.2	-21.4	32.7
United Kingdom	-2.3	-43.5	-28.7	-18.2	32.4
<i>Group 2: Relative Structural Improvement</i>					
Austria	32.1	-33.9	-6.0	21.3	54.3
Finland	39.6	14.8	-11.2	12.2	65.7
Japan	37.3	-2.3	27.4	7.5	90.2
Norway	51.1	-21.6	-40.3	34.7	87.5
<i>Group 3: Structural Deterioration</i>					
Bulgaria	74.9	24.9	42.3	77.5	37.3
Czechoslovakia	31.5	22.5	37.3	62.9	33.9
Greece **)	119.3	67.3	162.9	43.1	69.1
Portugal **)	89.0	34.2	133.1	27.4	69.0
Soviet Union	76.3	33.4	35.9	70.2	47.7
Turkey	218.8	184.4	173.2	118.6	118.2
<p>*) Calculation of the Gross Domestic Product percentage changes on the basis of constant (1980) US-Dollars. Bulgaria, Czechoslovakia and Soviet Union data refer to percentage changes 1970/83 of the Gross National Product.</p> <p>***) Transport data only take railway transport data into account.</p>					

Source: Jänicke et al.

In Japan, the de-linking process was partly neutralized by the rapid growth in industrial production, and thus only resulted in "relative structural improvement".

In Czechoslovakia, no significant de-linking of economic growth from the four input factors took place (see Figure 2). The development profile of this country, with sluggish structural change, is to some extent representative of the other economies of Eastern Europe.

Figure 2: Structural Economic Change in the CSSR, 1970 - 1985 (1970 = 100)



Source: Jänicke et al.

### 1.3 Trends Towards Industrial Restructuring

Despite certain analytical limitations of such empirical research (as e.g., the selection of only four input factors), several conclusions can be drawn from this international comparison as regards to the trends of industrial restructuring<sup>4</sup>:

- o Structural change in the form of de-linking economic growth from environmentally relevant inputs was evident in most but not all of the countries studied.
- o Several countries enjoyed environmental gratis effects as a result of active structural change. In some cases, especially for Sweden, these effects were quite considerable.
- o In other countries, the possibly beneficial environmental effects of structural change were levelled off by the rapid industrial growth pursued. This was especially true for Japan.
- o The strong correlation between the level of production (GDP) and environmental impacts, still evident in the 1970s, had dissolved in the 1980s. The high-income countries featured fairly rapid structural change.
- o In the medium-income countries, a distinct pattern emerged in that there were cases of rapid quantitative growth and cases of qualitative growth, i.e., economic growth with constant or decreasing resource input.

All in all, it is therefore not yet possible to speak of one dominant trend towards industrial restructuring. However, the environmental gratis effects of active structural change are highly evident and thus provide one strategic element of ecological modernization of industrial society.

## 2. PREVENTIVE ENVIRONMENTAL POLICY

Theoretically speaking, environmental policy could be defined as "... the sum of objectives and measures designed to regulate society's interaction with the environment as a natural system; it comprises aspects of rehabilitation, conservation, and structural adjustment".<sup>5</sup> Practice, however, does not conform to such a broad definition. Only parts of the interaction between society and environment become the subject of policy. So far, environmental policy has mostly been designed as react-and-cure strategies concerning air and water pollution, noise, and waste, with emphasis on the rehabilitation aspect.

For a variety of reasons, this conventional environmental policy was and still is meaningful and very much necessary. It has, however, a number of deficits, some of which are cited in the following, along with some suggestions for overcoming them through preventive environmental policy, i.e., anticipate-and-prevent strategies.

## 2.1 Environmental Expenditures - Environmental Damages

Since the beginning of the 1970s, when systematic records first began to keep track of the funds allocated for environmental protection, in the industrialized countries the sum of the respective public and private investments has reached large proportions. In the Federal Republic of Germany, for instance, this sum has come to the handsome total of over 250 billion Deutschmarks (or about 140 billion US-dollars). In a detailed study, Leipert et al. have computed and classified all existing data on investments and expenditures aimed at repairing and protecting the environment.<sup>6</sup> Table 2 shows the total and sectoral *environmental protection investments* for the manufacturing sector of the German economy for the years 1975 to 1985. Table 3 shows the *total costs of environmental protection* (current expenditures and depreciations) for both industry and government for the years 1975 to 1985.

Figures like these, however, are ambivalent. On the one hand, they give cause for proud political statements about the successes of environmental protection, according to the motto "the more, the better". On the other hand, they are - presumably - the absolute minimum of what is necessary to secure the very basis for society's sustainability. At the same time, they symbolize a serious structural deficit of industrial society: Environmental protection expenditures are spent when damage to the natural environment has occurred and can no longer be denied. Belated, they are repairs to the

Table 2: Environmental Protection Investments, Manufacturing Sector, Federal Republic of Germany, 1975 - 1985

Year	Total Investments		Waste Disposal		Water Pollution Control		Noise Abatement		Air Pollution Control	
	Current Prices	1980 Prices	Current Prices	1980 Prices	Current Prices	1980 Prices	Current Prices	1980 Prices	Current Prices	1980 Prices
in Millions of DM										
1975	2,480	3,090	170	210	900	1,110	200	240	1,210	1,530
1976	2,390	2,830	200	230	820	960	220	260	1,150	1,380
1977	2,250	2,560	200	230	740	850	210	230	1,100	1,250
1978	2,150	2,370	170	180	680	750	200	220	1,100	1,220
1979	2,080	2,190	260	160	760	800	200	210	960	1,020
1980	2,650	2,650	210	210	910	910	240	240	1,290	1,290
1981	2,940	2,810	250	240	950	910	210	200	1,530	1,460
1982	3,560	3,250	390	360	1,130	1,030	230	210	1,810	1,650
1983	3,690	3,270	290	260	1,100	990	230	200	2,070	1,820
1984	3,500	3,100	270	240	1,040	920	230	190	1,960	1,750
1985	5,620	4,940	330	280	1,060	910	260	220	3,970	3,530
Average Annual Change in %										
1975/84	+ 3.9	- 0.0	+ 5.3	+ 1.5	+ 1.6	- 2.1	+ 1.6	- 2.6	+ 5.5	+ 1.5
1975/79	- 4.3	- 8.2	- 1.5	- 8.6	- 4.1	- 7.9	0.0	- 3.3	- 5.6	- 9.6
1979/84	+ 11.0	+ 7.2	+ 11.0	+ 8.4	+ 6.5	+ 2.8	+ 2.8	- 2.0	+ 15.3	+ 11.4

Source: IIES research project.

Table 3: Total Costs of Environmental Protection, Federal Republic of Germany, in Millions of DM, 1975 - 1985

Year	Industry			Government			Industry and Government		
	Current expenditures	Depreciations	Total costs	Current expenditures	Depreciations	Total costs	Current expenditures	Depreciations	Total costs
At current prices									
1975	3,200	1,520	4,720	3,000	1,920	4,920	6,200	3,440	9,640
1980	5,180	2,250	7,410	4,690	3,390	8,080	9,850	5,640	15,490
1985	7,930	3,180	11,090	6,430	4,340	10,770	14,360	7,500	21,860
At 1980 prices									
1975	4,050	1,870	5,920	3,790	2,570	6,360	7,840	4,440	12,280
1980	5,160	2,250	7,410	4,690	3,390	8,080	9,850	5,640	15,490
1985	6,230	2,640	8,870	5,340	4,030	9,370	11,570	6,670	18,240

Source: IIES research project.

process of economic growth, signs of a "post-fact" policy that reacts to damages (and must react to them) but does not, or cannot, prevent them. Therefore, it is necessary to confront the "success stories" of environmental protection expenditures with figures on the environmental damages themselves.

Again taking the Federal Republic of Germany as an example, a recent estimation by Lutz Wicke showed that the *annual damage* to the natural environment is above 103 billion DM, or in the order of 6% of the GNP, and not 3%, as the OECD had estimated for the industrial countries some years ago.<sup>7</sup>

Table 4 is based on data on actual damage costs and findings from willingness-to-pay studies. Though the results must be taken with some care, the table illustrates that despite high annual environmental protection expenditures still enormously high environmental damages occur annually. Of course, this situation may not only be true for Germany but for many other countries as well.

There are more shortcomings of conventional environmental policy.<sup>8</sup> To name a few: Environmental policy usually identifies the given problem too late, so that the ecosystems affected cannot survive. As it is pursued as a *media-specific* policy, i.e., separately regulating air and water quality, noise or waste, it also runs the risk of lacking coordination between its specific goals, measures and institutions. And this then may result in shifting a problem from one environmental medium to another, e.g., from air to water or soil, or from one place to another, as is the case with long-range, trans-boundary pollution. In addition, environmental policy often becomes entangled in a debate on principles. If measures must quickly be taken, the argument gets shifted from the "*polluter-pays-principle*" - which is advocated in general - to the "*taxpayer-pays-principle*", thus switching the

burden of environmental protection from the individual polluter to the community, to government or to society at large.

Table 4: *Environmental Damage in the Federal Republic of Germany ("Measurable Damage" in Billions of DM per year)*

Environmental Sectors	Environmental Damage
<i>Air Pollution</i>	ca. 48.0
Health hazards	between 2.3 - 5.8
Material damage	more than 2.3
Degradation of vegetation	more than 1.0
Forest blight, etc.	between 5.5 - 8.8
<i>Water Pollution</i>	far more than 17.6
Damage to rivers and lakes	more than 14.3
Damage to the North Sea and Baltic Sea	far more than 0.3
Contamination of ground water, etc.	more than 3.0
<i>Soil Contamination</i>	far more than 5.2
Costs of Chernobyl disaster	more than 2.4
Rehabilitation of "yesterday's waste"	more than 1.7
Costs of preserving biotopes and species	more than 1.0
Other soil contamination, etc.	far more than 0.1
<i>Noise</i>	more than 32.7
Degradation of residential amenities	more than 29.3
Productivity losses	more than 3.0
"Noise rents," etc.	more than 0.4
Grand total of damage	more than 103.5

Source: Wicke.

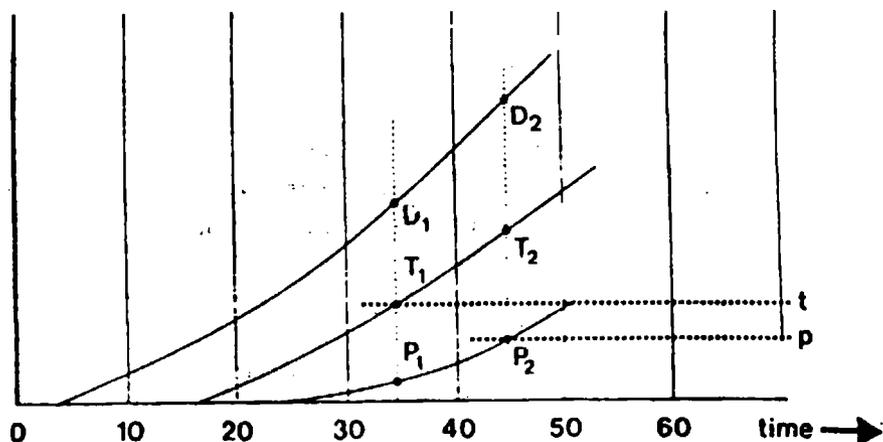
Thus, innovations in planning and implementation are needed. Preventive environmental policy - it seems - can counter the shortcomings of conventional environmental policy. But in order to switch to preventive policy, several conceptual as well as practical constraints have to be overcome.<sup>9</sup>

## 2.2 Prerequisites of Preventive Environmental Policy

According to Scimemi and Winsemius one can conceive three factors as concomitant policy relevant processes in time: The accumulation of environmental damage; the acquisition of technical knowledge; and the rise of public awareness. The time sequence of these processes, especially the relative timing of their critical level, is decisive for the whole issue of preventive environmental policy.

To illustrate the relationship between these three factors, Scimemi has redrawn a diagram suggested by Winsemius, using three separate functions: *Level of Damage*, *Level of Technical Knowledge*, *Level of Public Awareness*.<sup>10</sup> The relative position and the shape of these functions depends, of course, on the specific circumstances (country, environmental sector, historical phase) under consideration; the common case is illustrated in *Figure 3*.

*Figure 3: Factors of the Environmental Policy Cycle:  
Damage, Technical Knowledge, Public Awareness*



Source: Scimemi.

Line  $D_1 - D_2$  indicates the accumulation of environmental damage over time. The accumulation of damage starts at a given point in history (in the diagram somewhere between time 0 and time 10). At that point, neither the scientific community nor the general public is yet aware that anything of importance is happening. Line  $T_1 - T_2$  indicates the process of gathering technical knowledge. This process may not start until some time after damage has begun to accumulate (in the diagram somewhere between time 10 and 20), and proceeds gradually. During that phase the public may still be unaware of the hazard. Somewhere between time 20 and 30, public awareness starts to rise, as indicated by the line  $P_1 - P_2$ .

Within these concomitant processes, a certain stage becomes important (*critical level*). As illustrated, the technical understanding of the issue reaches a critical level,  $t$ , thus ensuring the first of two conditions required for effective policy action, i.e., *technical rationality*. Public awareness also reaches a critical level,  $p$ ; at that time the second condition for effective decision-making, i.e., *political viability*, is fulfilled. It is at this stage that action will be undertaken to avoid the occurrence of further damage.

Recalling past developments in environmental policy at the national or the international level, it is easy to recognize that the processes evolved very much in conformity with Scimemi's theoretical interpretation. Thus, the diagram may be considered to be a true representation of real events. (There are cases, however, where public awareness - line  $P_1 - P_2$  - started much earlier than technical knowledge - line  $T_1 - T_2$ .)

What are now the opportunities to influence these basic conditions of policy action in favor of preventive environmental policy? Figure 3 helps to formulate three general and two specific options<sup>11</sup>:

General options:

- o Retarding damage accumulation (i.e., sliding the  $D_1 - D_2$  curve towards the right)
- o Accelerating technical knowledge (i.e., sliding the  $T_1 - T_2$  curve towards the left and/or raising its slope)

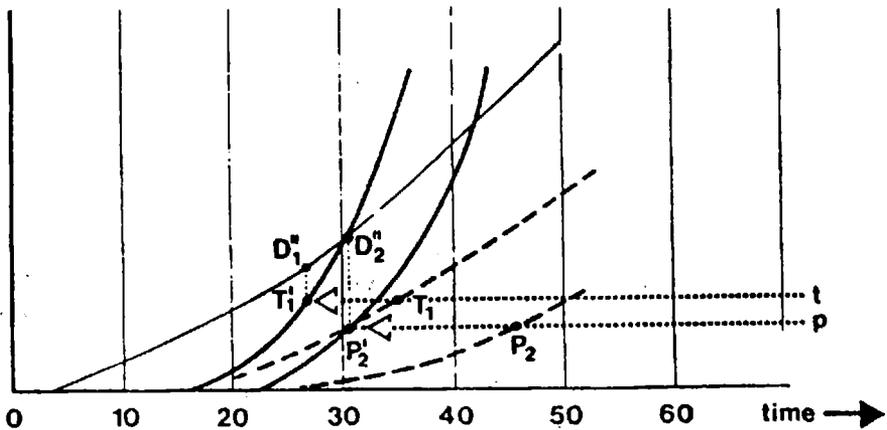
- o Increasing public awareness (i.e., sliding the  $P_1 - P_2$  curve towards the left and/or raising its slope).

Specific options:

- o Dynamic environmental standard setting (i.e., lowering threshold  $t$ )
- o Dynamic public participation (i.e., lowering threshold  $p$ ).

All these various options make policy decisions possible at a stage when the level of environmental damage is still relatively low, or even zero.<sup>12</sup> One of these options is illustrated in Figure 4.

Figure 4: Accelerating the Generation of Technical Knowledge and/or the Development of Public Awareness



Source: Scimemi.

### 2.3 Environmental Impact Assessment as Part of Preventive Policy

Acceleration of knowledge and awareness can, of course, be promoted through a variety of approaches and methods and depends a great deal on the specific environmental issue at

and. *Environmental Impact Assessments* (EIA) are increasingly being applied, not only for public but also for private investment projects. They entail efforts to learn more about possible environmental impacts, and are intended to allow appropriate action to be taken before damage has occurred. In that sense, environmental impact assessments can be classified as part and parcel of preventive environmental policy.<sup>13</sup>

During the last years, some headway has been made to institutionalize and standardize EIA procedures, nationally and to minor extent also internationally. As the EIA procedure is particularly used for specific investment projects, it allows for the "accelerating effort" to be targeted, and generally also permits the burden of such efforts to be imposed upon the project initiator himself, thus conforming to the *polluter-pays-principle*. A big deficit, however, remains in how to implement EIA as a preventive procedure in cases of global change, like climate warming or ocean pollution.

The required levels (thresholds) regarding technical knowledge and/or public participation in environmental decision-making differ widely from one environmental medium and country to the other.<sup>14</sup> The question of *how much knowledge/awareness is enough* normally falls upon the political decision-maker (the government, the environmental protection agency, the institution in charge of the problem), even if the scientific community (or parts of it) is ready to say "we know enough" and the public (or parts of it) is demanding "something must be done." Therefore, stalemates in decision-making on environmental issues are quite frequent.

What is "enough knowledge/awareness" for one country (government, agency, institution) may not be enough for the other. The normal outcome of such a situation is a meagre compromise over the *emission standards* to be implemented. They will be

weaker than technically/politically feasible because knowledge/awareness on cause-effect-relationships or social priorities is said to be insufficient. Eminent cases in point are the emission standards for SO<sub>2</sub>, CO<sub>2</sub> and NO<sub>x</sub> in the air pollution field, and the nitrate standard in the water pollution field. Thus, the dilemma of setting stricter emission standards is serious. Meanwhile the forests may continue to die back, the ozone layer may continue to be affected, and the water may continue to get contaminated.

The conclusion therefore is, that environmental standard setting must be conceived as a continuous process. With growing knowledge/awareness on actual and probable environmental damages the thresholds for action must be consecutively lowered, i.e., standard setting must be dynamized to speed up industrial restructuring.

This need to come to terms with the future is, of course, not unique to environmental policy. Implementing the prevention principle is especially requested in all other domains of policy where collective interests are at stake. One such major domain we have to address when discussing the possibilities and impediments of *ecological modernization* is economic policy.

### 3. ECOLOGICAL ORIENTATION OF ECONOMIC POLICY

"Ecology in essence means the necessary and feasible harmony between man and nature, society and environment." (C.F. von Weizsäcker). Economy, however, in general means disharmony with nature. Use is made of nature both directly and indirectly when raw materials are processed into products, and nature is polluted by the emissions and wastes generated by industrial production. These are, then, the two processes in which nature remains the loser. She exchanges natural raw

materials for produced waste materials. Besides labor and capital, nature is the truly quiescent and exploited third production factor.

### 3.1 Conflicts between Economy and Ecology

The use of raw materials and the generation of emissions and wastes are of course old, not new issues. Scientific and technological development, however, has made it possible to increasingly exploit the depletable resources, and has led to an ever increasing accumulation of harmful emissions and non-decomposable wastes. Nature is no longer able to absorb all of these substances, many of which are not only toxic for flora and fauna but for human beings as well.

Efforts to hide harmful emissions and toxic wastes - in land-fill sites, in transfer stations or permanent depositions, to spread them - through high smokestacks and incinerators, or to dump them - into the water bodies and abroad, have at best been temporarily successful because many emissions and wastes are "mobile poisons" or reappear in different form. These activities lead to a "linearization of ecological cycles," i.e., the natural diversity is reduced, the robustness of ecosystems declines, ecological symbioses and equilibria break down. As a consequence, environmental degradation increases and the absorption capacity of the natural environment decreases.

Accordingly, the conflict between ecology and economy can be attributed to two (actually or possibly) incompatible basic principles: The ecological principle of "stability," as a precondition for the sustainability of ecological systems, and the economic principle of "growth," as the inherent logic of economic systems - more precisely: the principles of business

profitability, national economic growth, and world market expansion.

Given the actual and the pending ecological crisis, the question on whether these economic principles can be changed, reshaped and finally brought into harmony with ecological principles, on which level, in what way, and at what time, is, of course, a controversial question in both theory and practice, and a specific challenge to the social sciences. The answer not only depends upon the respective individual and societal constellation of interests. It particularly depends upon the ability of and the willingness for social innovations, i.e., on (a) whether the potential of an ecological self-regulation of the economy is used, and (b) how the option of an ecological re-orientation of economic policy is implemented.<sup>15</sup>

### 3.2 Ecological Self-Regulation of the Economy?

To start with a general statement: Most certainly, only a small fraction of the current environmental problems would exist if the economic contexts would have remained so comprehensible, that producers and consumers would personally be able and liable to recognize and perceive the consequences of their own decisions towards depleting resources and polluting nature. Or, if business profitability, national economic growth, and the expansion on world markets could not be increased by externalizing parts of the ensuing costs. This is the old but still relevant - because unresolved - problem of the *external effects of production*. Scientific and technological development has been, and still is, coupled with negative external effects, i.e., the shifting of costs to society, future generations, and nature. With respect to the environmental problem, all these cost components are relevant.

One of the pending tasks thus can easily be prescribed: Internalize the external effects of production, shift the costs back to the economic units that cause the environmental problem, include the ecological perspective into all investment decision-making. Drastically reducing the external effects of production on society, nature, and future generations seems to be the necessary step towards regaining harmony between economy and ecology. But, how to proceed in practice and where to put priority?

To re-organize the economy towards a materially *integrated* cycle would, first of all, mean to reduce systematically the use of depletable resources and the generation of polluting emissions and wastes - and this is in contradiction to the prevailing "throughput economy" (K. Boulding). In practice, recycling and clean technology are still at an incipient stage and not systematic economic undertakings. Especially, the step from simply disposing wastes towards avoiding wastes ("low waste economy") has not been made.

Certainly, this is in part because many waste products cannot be recycled or only at high cost. But it is also true because adequate price and cost signals have not been set. Preventing waste generation and conserving depletable resources are still not sufficiently being promoted. This state of affairs, however, has also to do with the deficits of our economic accounting procedures which do not adequately measure the diminishing stocks. Therefore, two contradictory trends can be observed: *increasing monetary income - decreasing natural stock.*

Proposals for *ecological accounting* at the factory level and in the *national accounts*, however, are promising. With ecological accounting the amount of energy, materials, wastes, land use, etc. are being computed and, by simulating the given shortage, accounting units are determined which then enter the accounts. Thus a measure is developed which not only may guide

private investment decision-making, but at the same time will provide a public information instrument for promoting qualitative economic processes.

In industrial society another ecological principle is no longer valid, i.e., *sustainability of resource use*. Traditionally, forest owners for instance have followed the rule "Do not cut down more wood than you regrow." This rule is being undermined: externally produced acid rain collides with internal resource conservation; and accumulated external debt lead to over-exploitation of national resources. Sustaining the yield of the forest capital stock is being replaced by indirect expropriation or resource depletion.

Another basic principle to be re-established in the economy is that of *responsibility or liability*. With respect to environmental problems, the legal system, and also economic behavior, in most countries is marked by the strict proof of causality. Only when the injured (damaged party) can prove who caused the damage (polluting party), the polluter is held liable for compensation. Instead, in some countries (for some cases) statistical probability is sufficient for obligating industry to compensate for damages (*collective liability*). Once this principle was established by the courts and through legislation, it quickly helped to improve environmental quality through ecological self-regulation of business activities.

In general, the liability principle would support the anticipate-and-prevent strategy in environmental policy, and shift the technical solutions for environmental problems from ex-post to ex-ante approaches, i.e., from *controlling or end-of-pipe technology* towards *low emission or integrated technology*. To implement the principle in practice, small steps or big leaps can be taken: from continuous reporting on wastes or auto-

matic monitoring of emissions, to collective funds and to strict environmental liability.

### 3.3 Ecological Re-Orientation of Economic Policy?

Confronted with serious environmental damage, conventional economic policy is increasingly being challenged. Its guiding principles, goals, instruments, and institutions are being questioned, and a new concept is emerging: *ecological economic policy*.

Conventional economic policy is based on the *guiding principle* of maximizing flows: volume of production, income, profits, turnover ... (Kenneth Boulding seventeen years ago called this the "throughput economy.") Instead, the "ecological economy" is based on a different guiding principle, i.e., "increasing efficiency and maintaining substance!" Aspects such as environmental compatibility and resource conservation become important, and structural adjustment of products and technologies according to ecological considerations becomes the task.

Regarding goals, it seems necessary to redefine and supplement the conventional economic policy goals, especially to re-assess the growth target and to include "environmental stability" into the catalogue of economic policy goals. The conventional policy goal indicators were developed at a time when environmental pollution was already a problem but not yet a public issue, and since then they have not really been readjusted. Economic growth is still being measured in terms of goods and income categories only (GNP - Gross National product), while their effects on the stock and the quality of the resources (natural capital) are not adequately considered. In the conventional concept of economic growth, all monetary transactions are summed up independent of their

specific function; also, increasingly more expenditures are included which are solely being spent for damage originally caused by the production process ("defensive expenditures").

Qualified goal indicators for economic policy can be defined in various ways: Computations of defensive expenditures, i.e., assessment of an environmentally related net product (ENP - Eco National Product); combined growth and distribution indices (RWG - Redistribution With Growth); an integrated system of economic and environmental indicators, or an attached "Satellite System", etc.

Regarding *instruments*, conventional economic policy relies mainly on two instruments, i.e., variations of interest rates and of tax rates. From an ecological point of view, new taxes and charges are required which, to some extent, would replace traditional taxes. In a situation of structural unemployment and environmental pollution the introduction of resource taxes (as e.g., an energy tax) and emission charges (as e.g., charges on SO<sub>2</sub>, NO<sub>x</sub>, and CO<sub>2</sub> emissions), and a definite decrease of wage taxes are called for. Such a structural tax reform would change the existing incentives in the economy towards promoting resource efficiency and increasing employment opportunities.

Economic policy manifests itself in and works through particular *institutions*. Therefore, an ecological orientation of economic policy also requires creating new institutions, and abolishing or redefining old ones. (The current debate on the negative environmental effects of decisions by the World Bank and the IMF is just a case in point.) The actual and the pending environmental crisis require structural institutional reforms by which economic institutions would have to incorporate the ecological perspective, environmental institutions would have to improve their competence - and by which environmental impact assessments (EIA) would be integrated into all major economic decision-making.

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