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EFFICIENCY: THE SUSTAINABILITY CRITERION THAT PROVIDES USEFUL GUIDANCE FOR STATISTICAL RESEARCH

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Introduction

The three pillars of Sustainable Development, economic, social and environmental, throw up a large number of potential 'indicators' for each of the pillars, but unless these can be linked, they do not necessarily help to answer the fundamental questions:

- Are we moving towards a more sustainable society/economy?
- Is our economy progressing at the expense of the environment? Or of the health of society?
- Are the 'improvements' we see in some environmental indicators real improvements or simply a result of a sluggish economy, or of the 'exporting' of environmental problems to other countries?

While eco-efficiency indicators cannot answer all these questions, they attempt to link the different pillars, to produce at least a partial answer to some of the questions.

Sustainability as a policy strategy in the European Union

Sustainable development was introduced as an explicit objective of the European Community in the Single European Act (1987). The requirement that environmental considerations be integrated into all Community policies was added in the Maastricht Treaty (1992), which established the EU as an international organisation in its own right, and was later reinforced in the Amsterdam Treaty.

The Cardiff European Council in June 1998 explicitly raised the need to measure the integration of environmental protection into Community policies, including a requirement to produce indicators to monitor progress. Other European Councils have extended the list of policy areas required to produce 'integration' indicators.

Building on the so-called Lisbon strategy (2000) and its political commitment to economic and social renewal, the Gothenburg European Council in June 2001 confirmed that the Union’s Sustainable Development Strategy (*A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development*" COM(2001)264) is based on the principle that the economic, social and environmental effects of all policies should be examined in a co-ordinated way and taken into account in decision-making.

Sustainability measurement criteria

Sustainable development implies the acceptance of the ‘biophysical limits’ of the planet. The major conceptual problem linked with the evaluation of these limits is the fact that the majority of them are not priced by the market or are priced at a level that doesn’t reflect their ‘ecological value’. This generates the problem of how to evaluate them per comparison with economic standard measures (through indicators, indicator frameworks or econometric models).

The capital stocks criterion

According to economic theory, the capacity of society to develop is based on the existence of capital stocks in their three axes, i.e. natural, human and man-made capital.

Human and man-made capital and their substitutability can be subject to measurements established by the economic science (by the total and marginal substitution rates). Major conceptual issues arise to the possible measurements of natural capital and therefore to its substitutability. To conceptualise these issues the debate on 'weak sustainability'[†] and 'strong sustainability'[‡] schools of thought have to be taken into account.

A key issue under discussion between these schools is the substitutability between the different stocks of capital. While the 'weak sustainability' adepts consider that different forms of capital can substitute each other, the 'strong sustainability' adepts demand the conservation of total capital due to the non acceptance of the possibility of substitutability or replacement of the critical natural capital. No measurement is nevertheless proposed that can be consensually accepted for critical natural capital.

Both schools claim nevertheless that the establishment of 'environmental targets', at some degree, is needed to support the policy-decision process.

The efficiency criterion
Means essentially that resources are not wasted and that maximum aggregate wellbeing is derived from a given stock of resources. This provides a useful guideline for the measurement of sustainability in economic sectors.

In the past years, statistical research on this issue has advanced mainly in some industrial sectors. Eco-efficiency, as it has been named, is closely linked to the EU environmental and sustainable development policy, particularly in the Community approach of integration of the environmental policy in all the other EU policies.

The most widely spread and used definition of eco-efficiency is the one currently provided by the World Business Council on Sustainable Development (WBCSD), which reads as follows:

> "Eco-efficiency involves the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity."

The equity criterion
Equity is complementary to the efficiency concept in terms of sustainability. To the efficient allocation of resources, an equitable distribution of welfare gains and costs has to be aimed at.

It has a broad scope with regard to sustainability issues. It encompasses the inter-generational equity, the equity between developed and developing countries, and between stakeholders in

[†] '…that amount of consumption that can be continued indefinitely without degrading capital stocks, including natural stocks' (Costanza et al. (1991)).

[‡] ….includes the *cost of conservation,* i.e. the sacrifice of consumption that has to be made in order to conserve capital stocks at its existing level'. (David Pearce (2000).

one country (public/private/citizens), implementing the essence of the sustainability-definition in the Brundtland report and of the polluters-pays-principle.

Equity measures must therefore be established over space, between stakeholders, social groups and countries.

The dimensions of sustainability

In a brief way the three dimensions of sustainability are usually described as follows:

- The ecological dimension refers above all to the management of natural resources;
- The economic dimension relates to the efficient use of resources;
- The social dimension, taken in the restrictive sense, relates to labour opportunities offered, equal opportunities (between social groups) and society's ethical concerns. In a broader sense it encompasses consumption patterns and disparities.

So far attempts to describe and combine the ecological and the economic dimensions have been done by the various national accounting frameworks that are linked to environmental issues, such as the System of Environmental and Economic Accounting (SEEA), the accounts for natural assets, the emission accounts (NAMEAs), the material flow accounts, the environmental expenditure accounts, etc.

These have been developed by Eurostat (usually in co-operation with other international bodies and countries) and are at several stages of development.

The social dimension has not yet been approached in statistical research and the closer background may be found in studies on 'sustainable consumption' mainly developed by the OECD and in the Human Development Index (HDI), developed by the UN, a composite measure reflecting life expectancy, educational standard and average income.

Other conceptual studies/projects are the "Green National Product" approach, where economic output is adjusted to changes in environmental (resource depletion and environmental pollution) and social capital (such as health, income inequality).

How useful these approaches are for the decision-making process is still largely unknown.

The eco-efficiency concept and indicators

Eco-efficiency is a measure of environmental performance. Its advantage lies in the fact that it can combine economic and social performances with ecological performance**.** The following type of ratios describes the environmental productivity or eco-efficiency of an economic sector:

Eco-efficiency = Economic Indicator/Environmental indicator

Environment is a more complex 'input' than labour or capital. It encompasses several different components from environmental withdrawals (inputs of the sector) to environmental releases (outputs of the sector).

Relevant economic indicators that can be used are gross value added (a measure of the wealth) and employment (a relevant social problem).

Using these as numerators we can describe the environmental performance of one sector and its trends over time.

Environmental indicators are indicators of the 'use of nature', in terms of natural resources, and releases with environmental impacts. In this sense, a good evolution means a decrease in the value of the ratio.

These indicators can also be designed in inverse order, i.e.:

Eco efficiency = Environmental indicator/Economic indicator

For certain types of analyses, this presentation is clearer. For example calculating the pesticide consumption or the water use per unit of gross value added or per annual work unit (the measurement unit used in the Economic Accounts of Agriculture) provides information on the efficiency of the use of capital and labour in ecological terms.

They 'integrate' dimensions and criteria of sustainability

The purpose of this type of indicators is to integrate consistently the ecological, economic and social dimensions in one single and and easy to understand set of indicators.

By measuring the efficiency of the use of natural resources and at the same time the efficiency of the releases of the economic production they are adequate to answer to the capital stocks and efficiency criteria requirements. The equity criteria can be approached by comparing, for example, the results obtained between developed and developing countries and the results from previous decades with the present.

The alternative is the development of indicators frameworks that would reach a large number of dimensions. For example, sustainability criteria (3) multiplied by sustainability dimensions (3) equals 9 levels at the top of the 'iceberg'.

These type of frameworks cannot be considered friendly because the framework becomes the focus of the discussions. The decision of where to locate the actual indicators within the framework has to be reached by consensus, which leads to the fact that the location of each indicator (in which of the nine dimensions and the subsequent ones) cannot be made clear to the majority of the users. Additionally the picture provided is not an 'integration' of the dimensions but is instead the traditional 'separated' approach.

They can be used to quantify ‘environmental targets’

The calculation of time series of objective and sector-oriented eco-efficiency indicators enables the establishment of ‘policy targets’. The sectoral approach is very relevant for the calculation of a larger and more consistent set of indicators (most of the statistical information is organised or can be organised according to sectors). The policy-decision making process has also a macro and a sectoral approach.

They help to understand differences or similarities observed between countries and sectors

The values of the majority of the physical environmental indicators are correlated with the specialisation profile of one country (or region), with the population density and the consumption pattern of its population.

The use of physical parameters is useful to provide an overview. But to understand them we have to find the economic and geographical reasons for the differences or similarities among these figures. For instance, we know why water for irrigation is predominant in Southern European countries (relatively strong agricultural production and climatic conditions) but how to compare the amount of irrigation water used in Portugal with the amount of irrigation water used in Greece? We have estimates on the amounts of water used by manufacturing industry in Germany and in Sweden but how can we compare these two figures without additional information on the economic activities developed in these two countries?

We can make this comparison by calculating environmental statistics on a per capita basis, which is interesting to provide an overview in one country and region, but it is a rather poor method to compare countries or regions with various economic, geographical and social backgrounds.

They provide the grounds for some explanations

The calculation of time series of objective and sector-oriented eco-efficiency indicators enables a better understanding of what are the reasons that have lead to a better or worse environmental performance. For example are we polluting less because we are producing less? Or are we being really eco-efficient?

They help to test the reliability of the physical parameters

We are all perfectly aware of the fact that environment statistics are rather complex to compile and subject to weaknesses (of course economic and social statistics also face problems). We also know that international statistics are especially difficult to compare and analyse. We are in need therefore of measures to assess the quality of international statistics.

By combining different international data sources and different variables we can have a ‘better measure’ of the quality of the data we are using.

A first study/attempt to produce indicators

The objective of the study was to create a framework for industrial eco-efficiency indicators and to calculate and analyse a first set of indicators for two sectors of industry in two Member States.

The framework for these industrial eco-efficiency indicators is based on the notion of economic performance and core environmental issues linked to that performance, such as use by the industry of natural resources (inputs: materials, water, energy and land) and pollutant releases (outputs) leading to climate change, acidification, stratospheric ozone depletion, etc.
Eco-efficiency is calculated as a ratio of economic and environmental performance.

$$\text{Eco - efficiency} = \frac{\text{Economic output}}{\text{Environmen tal influence}}$$

This study uses value-added as the indicator of economic performance. Physical data on inputs to and environmental releases from the industry provide the environmental influence.
The chemical industry (NACE Rev.1, 24) and metal industry (NACE Rev. 1, 27) in the Netherlands and France were selected to test the indicator framework, based on data availability and consistency, and on the importance of the industry itself. The indicators were compiled from data in Eurostat and in other sources. Because of data constraints, the evaluation was restricted at this first phase to the following environmental parameters:

1. Chemical industry: energy consumption excluding coke, non-renewable energy consumption, fuel consumption as a feedstock, CO2 emissions, NOx emissions, NMVOC emissions, waste generation.
2. Metal industry: energy consumption excluding coke, non renewable energy consumption, coke consumption, CO2 emissions, NOx emissions, NMVOC emissions, heavy metals air emissions, waste generation.

The interpretation of the eco-efficiency ratios is simplified by grouping them into four degrees of eco-efficiency: fully eco-efficient, semi-eco-efficient, semi-non-eco-efficient and fully non-eco-efficient.

The conclusions drawn from the four sub-sectors are very different. However, the aim is not to make inter-sectoral comparisons. Rather, it is to see what progress, if any, is made in each sub-sector according to a selected set of eco-efficiency indicators.

The eco-efficiency snapshot of the Dutch chemical industry, covering the short period 1994-1996, is ambivalent: energy consumption, NMVOC and CO2 emissions indicate semi-eco-efficiency, while NOx is half non-eco-efficient and waste generation is fully non-eco-efficient. However, the long-term analysis of the eco-efficiency degrees shows much better progress, all five indicators being eco-efficient. The same appears with respect to the Dutch metal industry over a long-term period (ten years), when it was highly eco-efficient in terms of waste generation, heavy metal emissions and coke consumption.

All eco-efficiency indicators of the French chemical industry are eco-efficient over the short term as well as over the long term. Over the long term, the sub-sector is fully eco-efficient concerning its energy consumption and its CO_2 emissions, however it became half eco-efficient over the short term of 1994-1996. The snapshot covering the short period of 1994-1995 shows the French metal industry to be globally inefficient. Nevertheless, over the longer term (ten years), the sub-sector is eco-efficient with respect to use of coke as well as emissions of heavy metal and CO_2. The eco-efficiency ratios of energy consumption in the French metal industry were half non-eco-efficient between 1986 and 1996. Waste generation is fully non-eco-efficient over the same period.

Consequently, the results from the first set of eco-efficiency indicators for chemical and metal industry show that shortcomings in data govern the results and thus give a somewhat biased picture of the reality for the moment. The data currently available shed light into some core aspects of industrial eco-efficiency and ought to be expanded to respond to all core issues specified in the general framework.

In the results, the best assessments of the developments can be made on the basis of long-term trends. The annual variation governs the short-term variation and it's difficult to make any conclusions on the basis of the 2-3 year data.

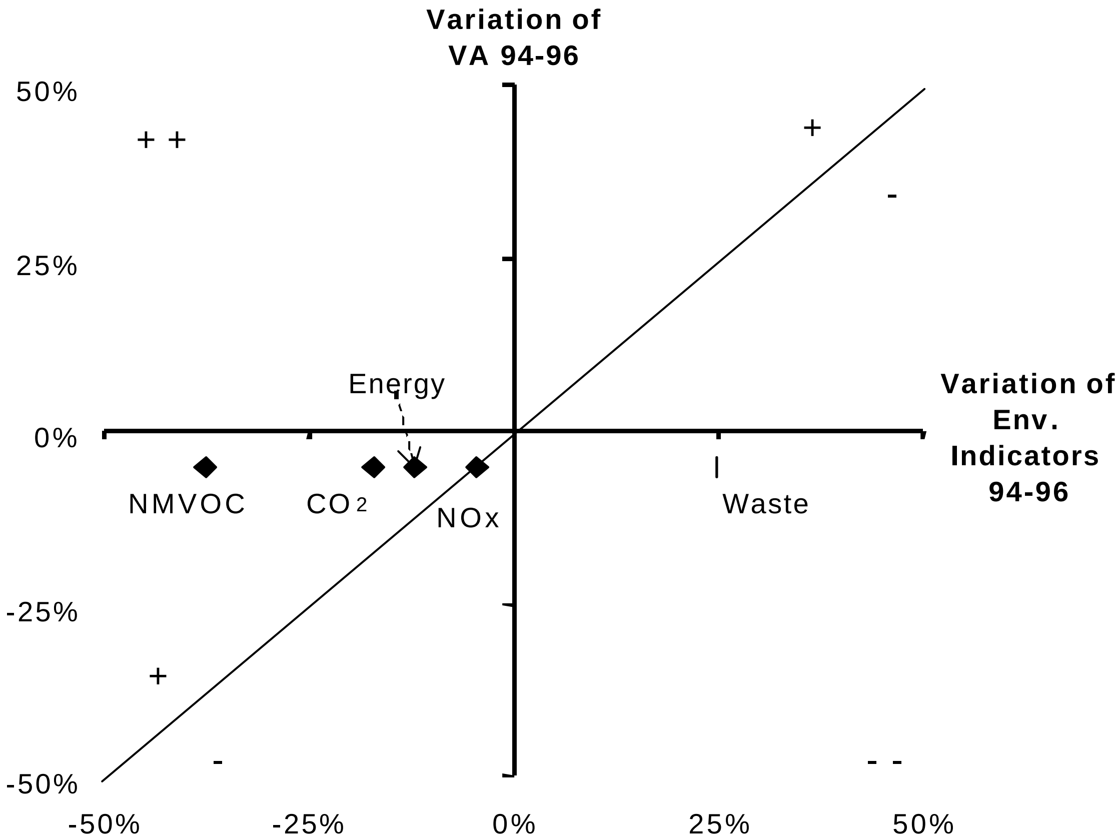
ANNEX: EXAMPLES

Snapshot
of the Dutch chemical industry in 1994-1996

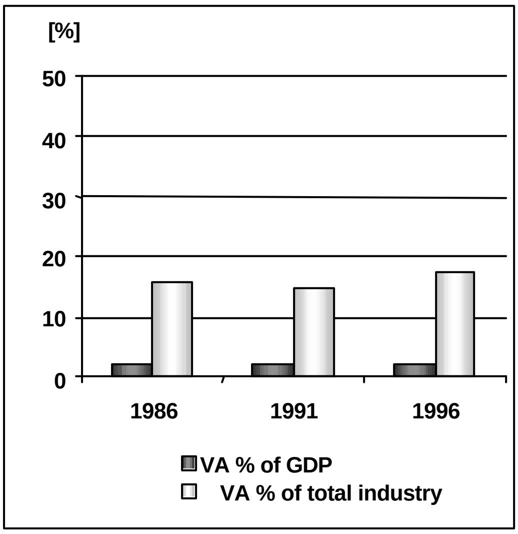
The value added of the Dutch chemical industry decreased by 5% between 1994 and 1996 meaning that this sub-sector could never be fully eco-efficient (++) over this period.

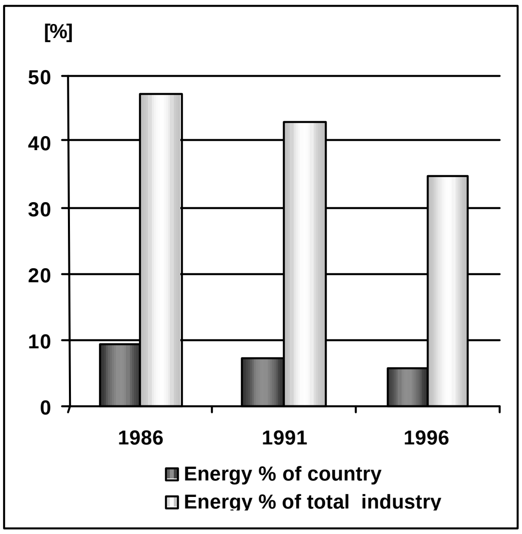
Nevertheless the development in emissions of NMVOC, CO_2 air emissions and energy consumption are half eco-efficient (+), i.e. they decrease faster than the VA decreases.

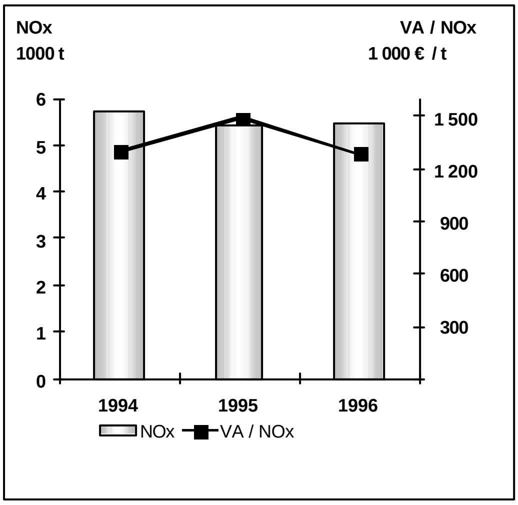
NOx emissions also decrease but les than value added, therefore in this case, the Dutch chemical industry is half non eco-efficient (-) and for waste, the sub-sector is fully non eco-efficient. (--).

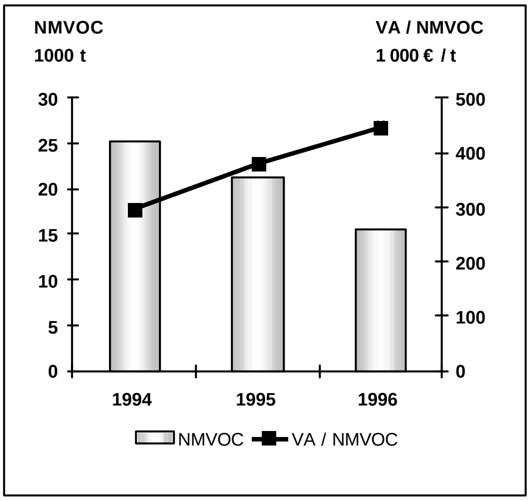


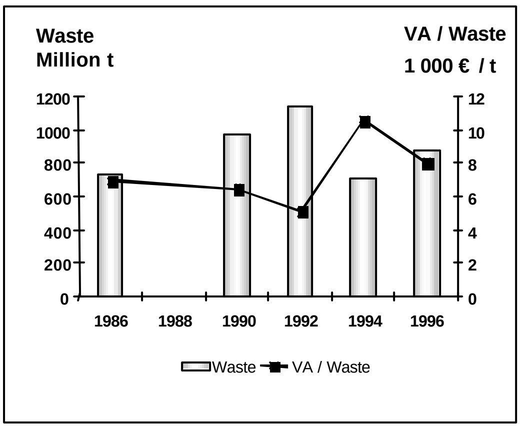
Eco-efficiency: indicator by indicator
For the Dutch chemical industry









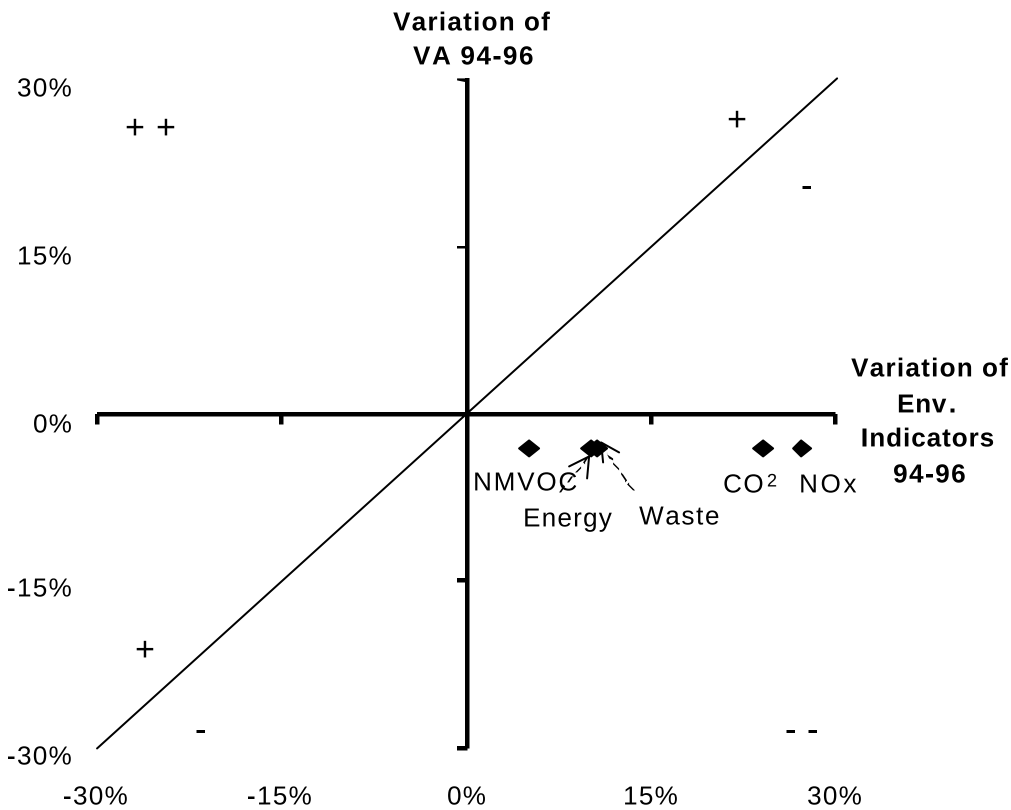


Snapshot
of the Dutch metal industry in 1994-96

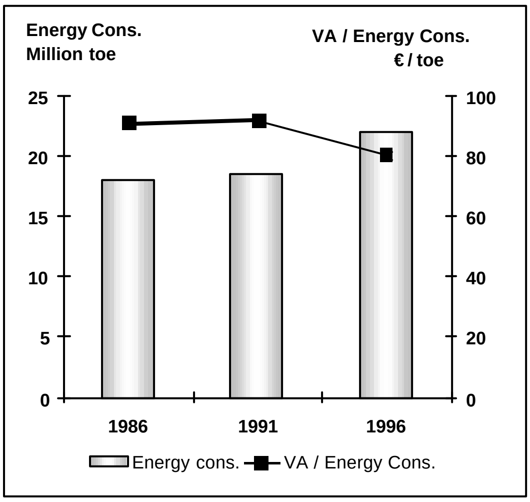
The value added of the Dutch metal industry decreased by 3% between 1994 and 1996, meaning this sub-sector could never be fully eco-efficient (++) over this period.

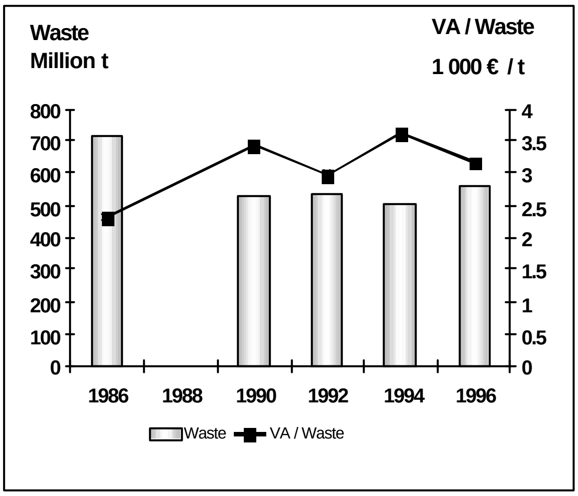
Moreover the five eco-efficiency indicators are fully non eco-efficient, i.e. the value added and the environmental indicators evolved in the unfavourable direction. The value added decreased and the environmental indicators increased.

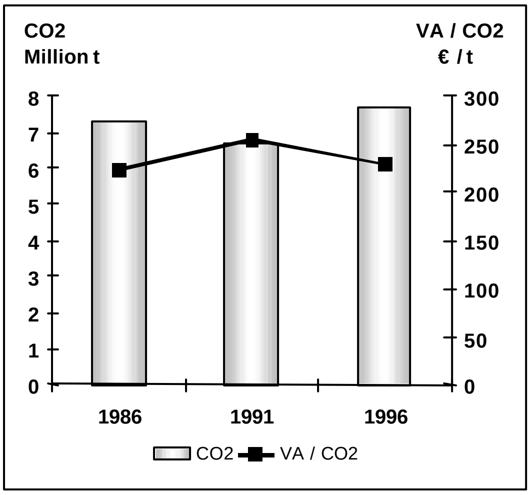
Therefore, in this case, the Dutch metal industry is fully non eco-efficient (--) over this period.

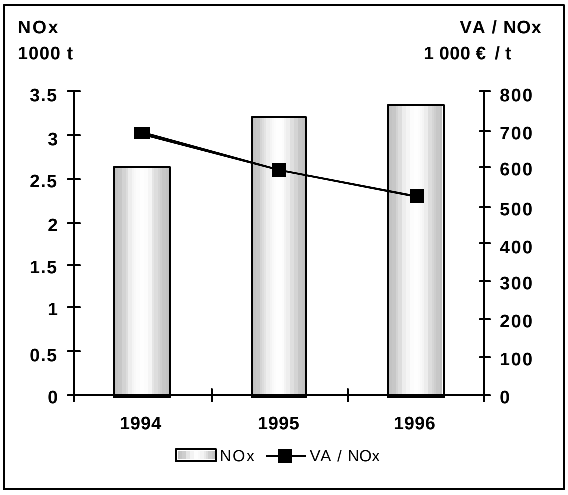


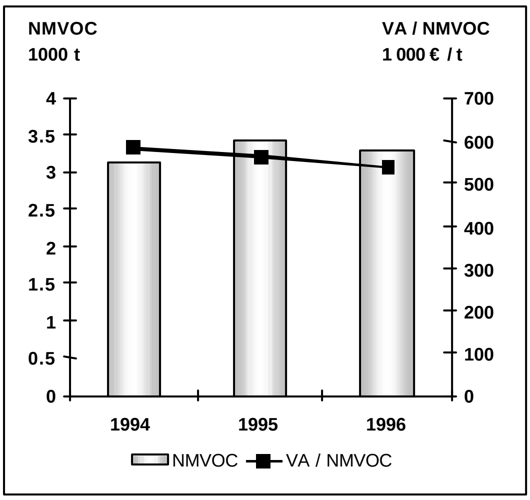
Eco-efficiency: indicator by indicator
For the Dutch metal industry

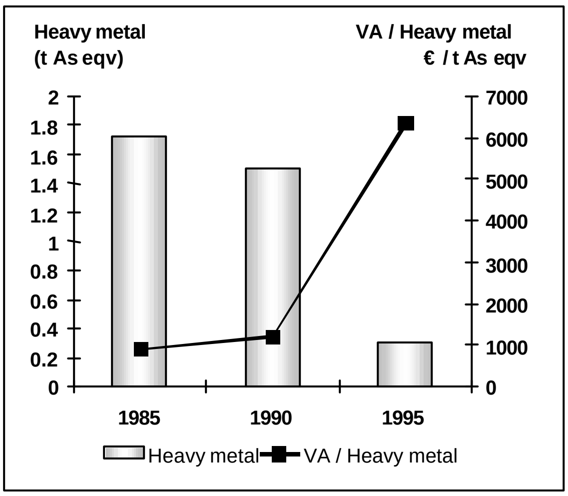










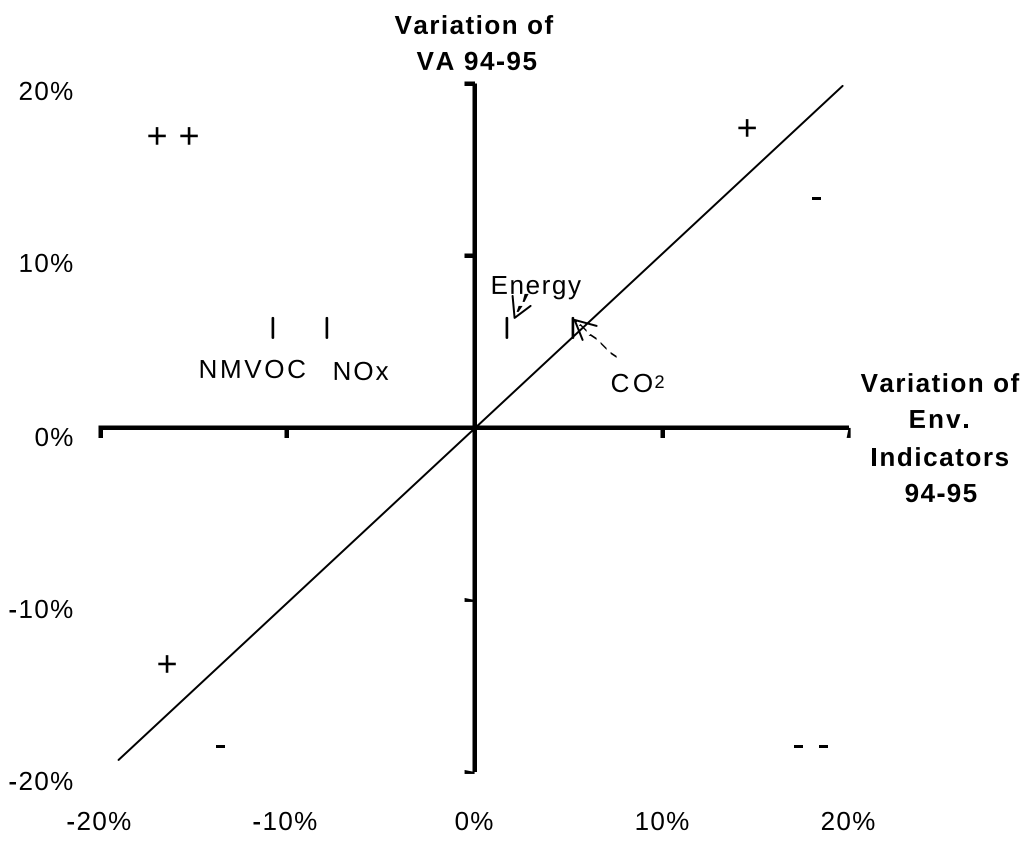


Snapshot
of the French chemical industry in 1994-95

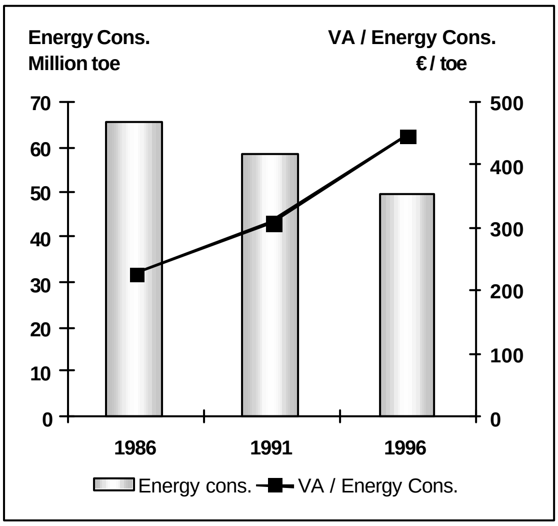
All eco-efficiency indicators are above the diagonal, meaning that they are all eco-efficient.

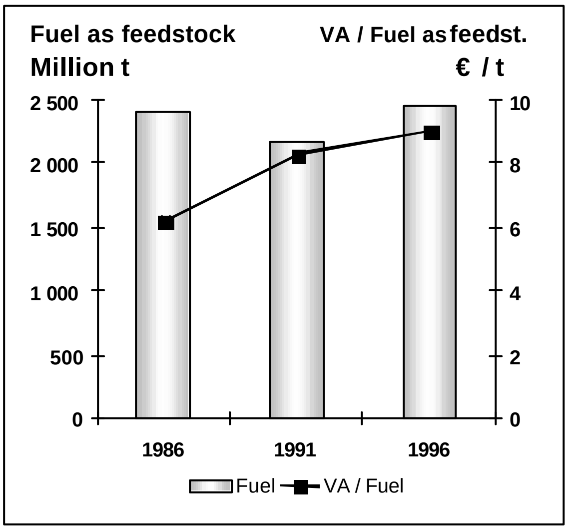
Two of the eco-efficiency indicators are fully eco-efficient (++) i.e. NMVOC and NOx emissions, which have decreased while VA increased.

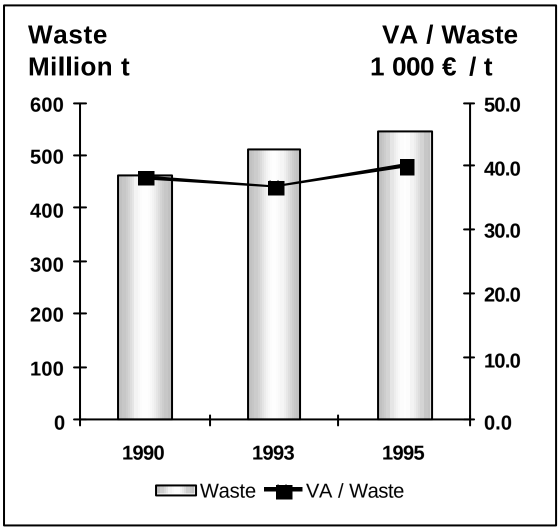
The remaining three are half eco-efficient (+) i.e. energy consumption, waste generation and CO_2 emissions, which increase but not as fast as Value Added increases.

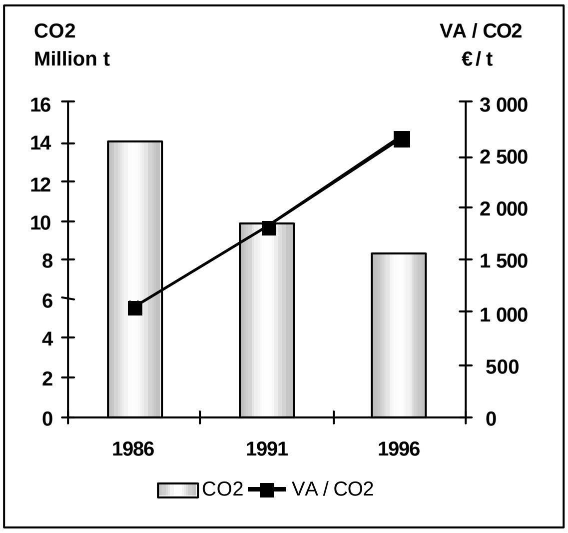


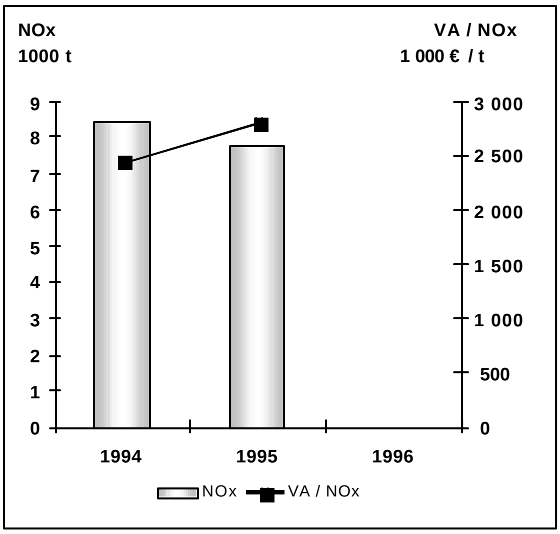
Eco-efficiency: indicator by indicator
For the French chemical industry

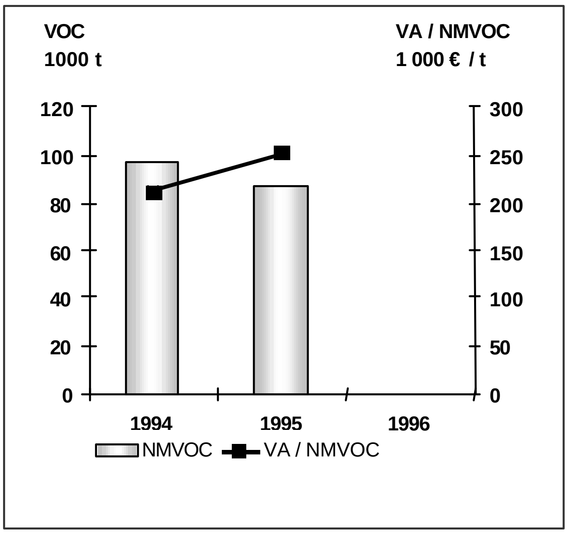








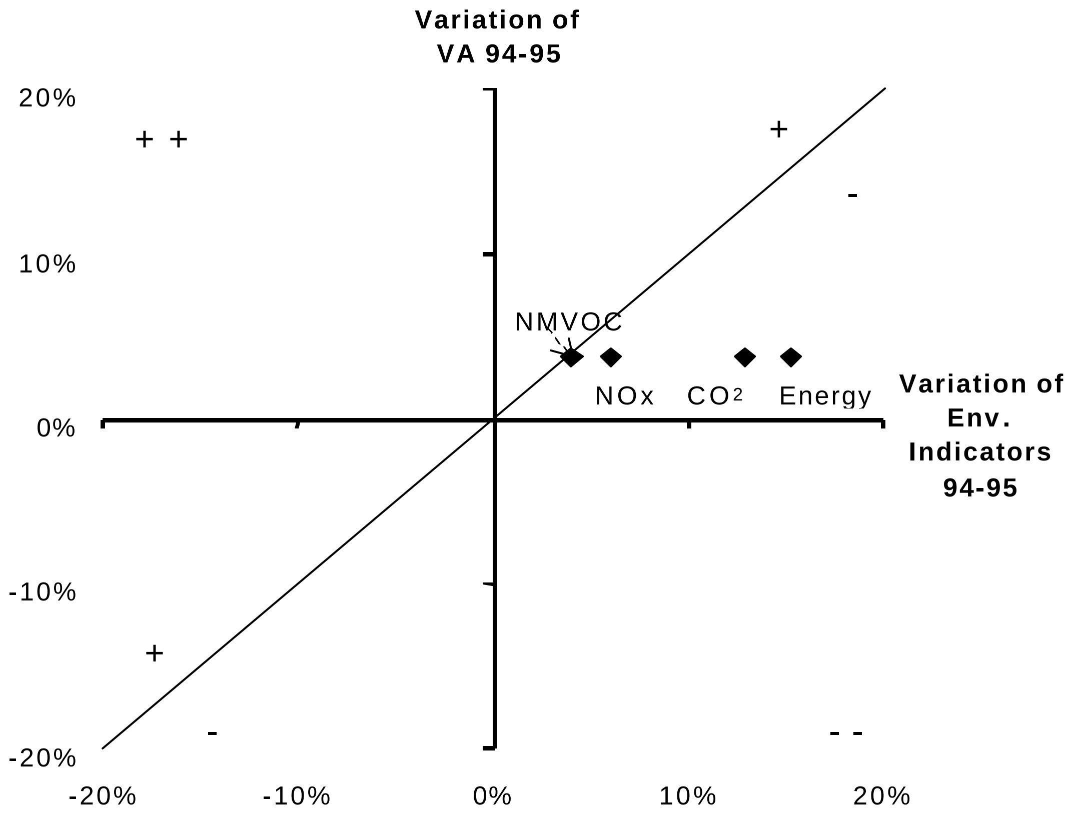




Snapshot
of the French metal industry in 1994-95

Waste generation increased by 3% between 1993 and 1995; however, VA increased by 16% over the same period, therefore the French metal industry is only is half eco-efficient (+) as far as waste generation is concerned.

All the other indicators are half non eco-efficient (-). Energy consumption, NMVOC, NOx and CO2 emissions increase but not as fast as the VA increases.



Eco-efficiency: indicator by indicator
For the French metal industry