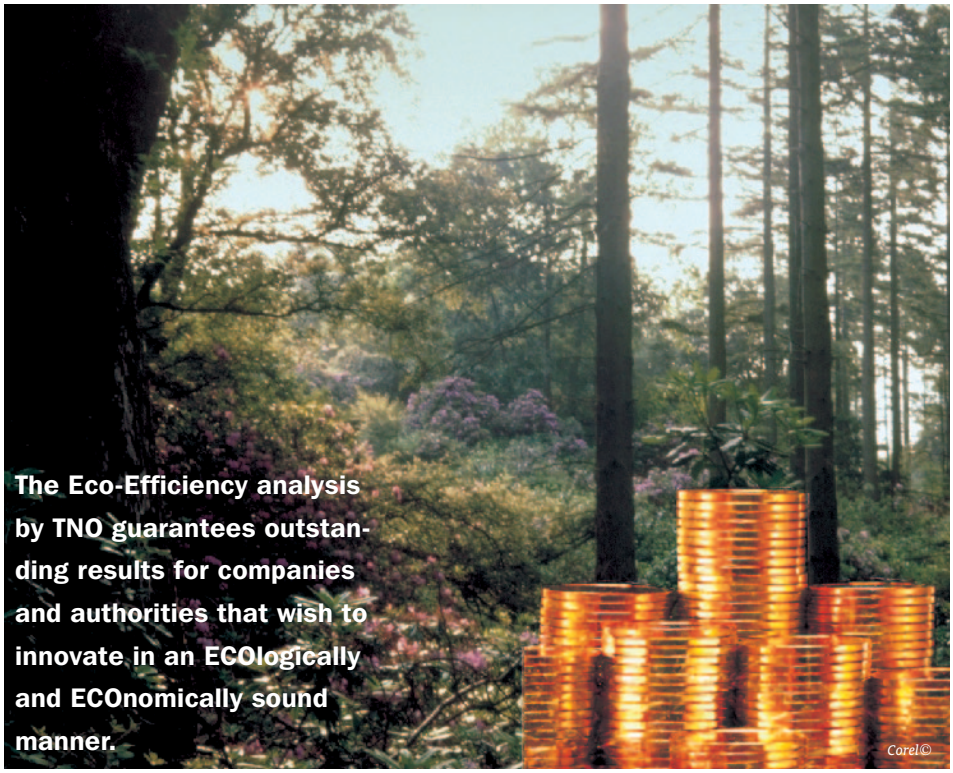
TNO | Knowledge for business

TNO helps you to improve your score with the Eco-Efficiency analysis

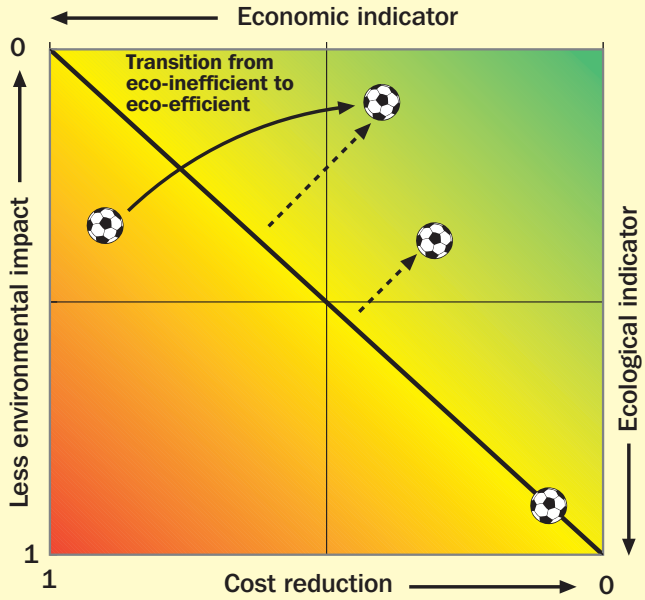


The Eco-Efficiency analysis by TNO guarantees outstanding results for companies and authorities that wish to innovate in an ECOlogically and ECOnomically sound manner.

Sports clubs invest in talent to reach their goals, whether their aim is to win the Champions League, European or national titles, or to become the best at a regional level. If success remains beyond reach, however, a club will usually end up with a very nervous board or sponsor. It's almost the same with Sustainable Business and Policy; the difference, however, is that enterprises/authorities do not know the outcome in advance if environmental goals and investments are balanced against one other.

The Eco-Efficiency analysis by TNO – which is based on a process of modelling – can provide you with a simple, graphic display of the environmental and financial effects of (complex) innovations. TNO uses the following standardized methods to determine both effects:

- The Life Cycle Assessment (LCA) method for environmental analyses; and
- The Life Cycle Costing (LCC) method for financial analyses.



It is easy to assess system's scores. Systems in the top right corner are eco-efficient (the best). Those in the left bottom corner are eco-inefficient (the worst). The distance to the reference line says something about the level of eco(in)efficiency.

"The Eco-Efficiency analysis provided by the graphical presentation has been developed by BASF in 1997. With regard to this concept TNO succeeds to continue and adds some other aspects to it in the case of external requests. For the calculations of the ecological and economic indicator TNO uses their own methods."

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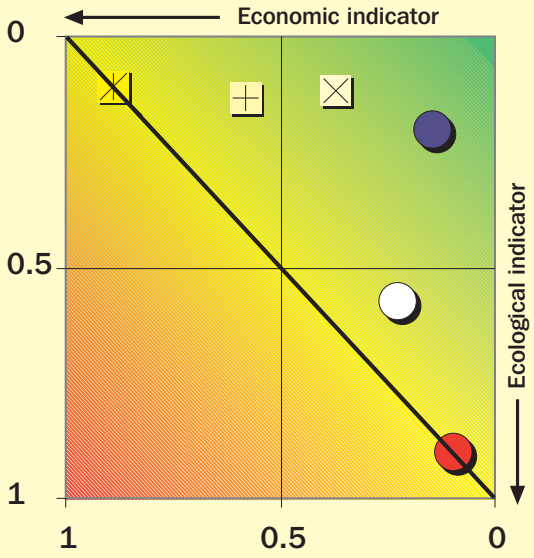
Examples of the use of the Eco-Efficiency analysis, and two potential uses

Six options for the processing of plastic packaging

From an eco-efficiency viewpoint, recycling of plastics is the most attractive option when it comes to processing plastic packaging. TNO has investigated the issue for APME (the Association of Plastic Manufacturers in Europe). A 15% material recycling + 85% incineration with household waste, including energy recovery, is clearly less damaging to the environment than the landfill option (the costs of both options are comparable); see the figure below.



landf	Integrated collection (together with other waste components) followed by landfill
NOW	The average existing concept in Europe; integrated collection followed by landfill or incineration and separate collection coupled to plastics recycling
R15	15% recycling of industrial and household packaging and 85% incineration (including energy recovery)
R25y	25% recycling of industrial packaging (foils, crates, etc.) and household packaging, incineration of the remainder with heat recovery
R35y	35% recycling of industrial and household packaging and 65% incineration with energy recovery
R50y	50% recycling of industrial and household packaging and 50% incineration with energy recovery

Figure 1 Processing of plastic packaging (Research performed for APME, 2001).

But what about the other options?
Above a certain level (between 15 and 20%) a higher material recycling does not result in an improved eco-efficiency, since recycling of large flows of relatively clean and homogeneous plastics, has already been implemented. More material recycling requires separate collection, mechanical reprocessing and cleaning processes of more contaminated plastic packaging. These extra process steps result in a considerable increase in costs, while the environmental benefits are marginal (in the case of more recycling, the points shift, as it were, horizontally to the left in Fig. 1). These eco-efficiency calculations clearly show that there is a particular point at which high-efficiency energy recovery becomes competitive with material recycling of yet to be separated contaminated plastic packaging mixtures.

Five options for the processing of refrigerators

The figure below presents the eco-efficiency values for several disposal options for discarded refrigerators. The landfill option scores badly because of the release of CFCs.

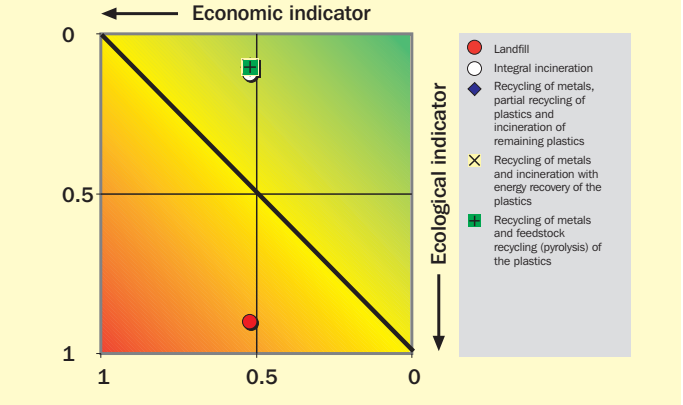


Figure 2 Discarded refrigerators with CFCs (Research performed for APME, 2002).

All other disposal options involve the risk of leaking CFCs. Therefore, the relative environmental impact is always larger than the relative disposal costs. This is the reason why the points of the five options that need to be compared are practically in one vertical line. As far as environmental impact is concerned, landfill differs largely from the other four options. The points of these options practically overlap.
If CFCs are replaced with other gases, a different picture emerges (see Fig. 3).

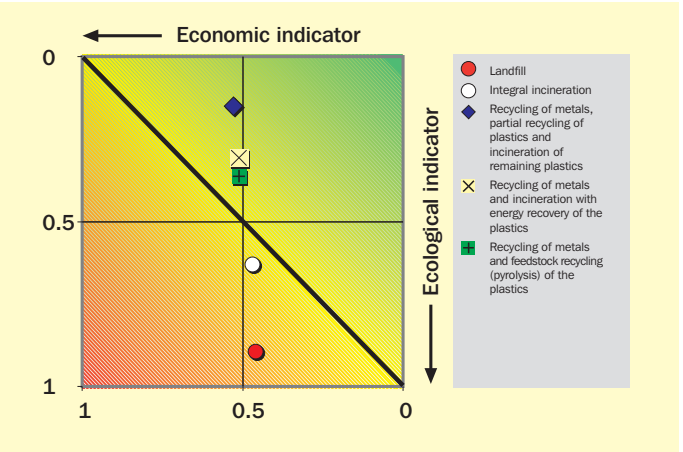


Figure 3 Replacing CFCs with other gases.

The environment indicator will still change more than the economy indicator, but it is no longer a dominant factor. There are also clear differences between the four options. In this case, recycling of metals and plastics from refrigerators is more attractive as regards eco-efficiency.

Different packaging for soft drinks

Another possibility is that improvement options or alternatives are built up from subactivities/processes, each with their own variations. Sensitivity analyses can then be used to visualize the options/scenarios that are most sensitive to these variations. TNO performed such an investigation for APEAL (The Association of European Producers of Steel

for Packaging). Eco-efficiency graphs show the level of sensitivity for variation within the total system. Fig. 4 shows an example in which TNO calculated the variation in system parameters for a number of packaging systems for drinks.

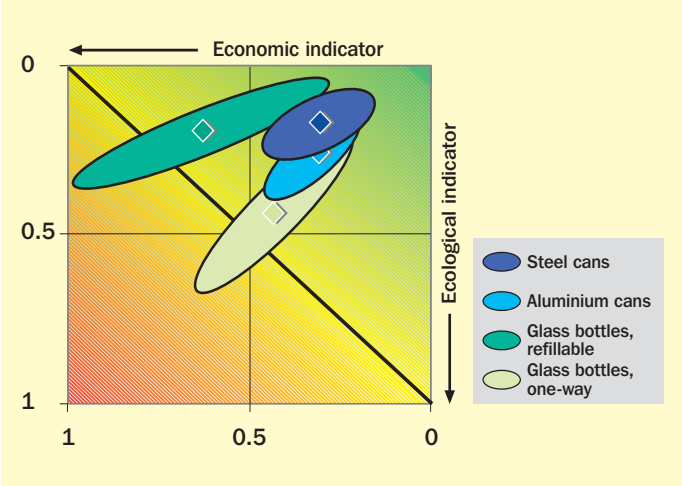


Figure 4 An example of spreading in the eco-efficiency analysis (Research performed for APEAL, 2002).

Major variable packaging parameters include weight, quantity of recycled material, waste scenario, and transport distance between filler and supermarket. Individual points are located in this eco-efficiency graph. Clouds of dots are visible around an average within which the system is found. Because of the spreading in the systems' eco-efficiency and a large system overlap, there is no significant difference in eco-efficiency. The conclusion is that assessing one of these packaging systems on the basis of just one value per system can lead to incorrect findings.

Process innovation

On the basis of the eco-efficiency analysis, BASF in Ludwigshafen (Germany) has listed several processes for the production of indigo, a blue dye for jeans.

1. A traditional process applied until 1998 for the production of indigo as a granule; a dyeing process with hydrosulphite as a reducing agent.
2. Production of powdered indigo from the indigofera plant. Use was made of a traditional dyeing process.
3. Biotechnological production of indigo granules by way of fermentation. The dye-house also uses hydrosulphite as a reducing agent.
4. BASF developed a process in which indigo is produced as a 40% solution. The dye-house then uses less hydrosulphite.
5. The most innovative process: the synthetic production of indigo as a 40% solution. An electric current is used for reduction.

The following conclusions can be derived from Fig. 5. Production from plants is very expensive because of the low indigo concentration (< 1%) and is characterized by a relatively high environmental impact. Applying the process with the 40% solution produces less environmental impact. The application of the electrochemical variant is even better for the environment, as it also saves on costs, which makes it the most eco-efficient option.

This analysis led BASF to invest in a production process based on the 40% solution in 1999.

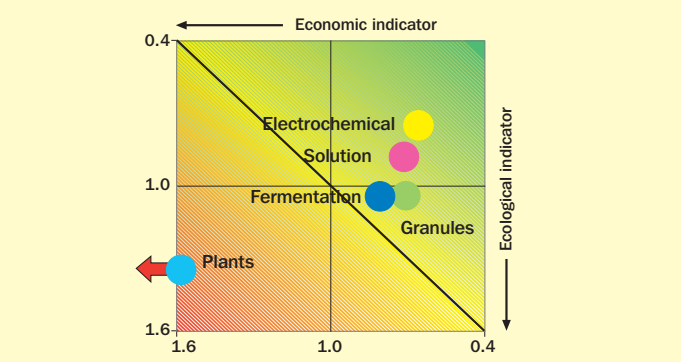


Figure 5 Five production processes for indigo (Source: BASF, Ludwigshafen, Germany).

BASF has strongly intensified its R&D efforts in the electrochemical process, while heavily reducing those in the alternative bio-technological process. The success of these measures that were based on the eco-efficiency analysis is that the market share of the indigo solution has increased from 2% to 40% within two years. BASF now has an environmentally safe process for indigo production.

Options for energy supply in houses

The municipality of Apeldoorn, The Netherlands, wanted to know the long-term options for energy saving in two existing residential areas. The current situation is a very traditional one: a central heating boiler supplies most of the space heating and tap water. The power network supplies most of the electricity for lighting. The use of so-called 'green' or environment-friendly electricity not only results in slight cost savings, but also in reduced environmental impact due to fewer CO_2 emissions. Saving energy by better insulation of the outer side of the houses (fronts, floors and roofs), in combination with an HE boiler, results in evident cost savings due to less natural gas consumption. At the same time, there is also a clear environmental advantage. When (industrial) residual heat is used, a gas-fired auxiliary boiler must also be applied. In the long run, this has clear environmental advantages. The gas consumption costs decrease, though they are replaced by costs for residual heat distribution. The total costs remain comparable with the traditional situation. Fig. 6 clearly shows that the option that is economically the most attractive – energy savings – also provides significant environmental advantages. An option with a somewhat higher eco-efficiency is utilization of residual heat. The use of 'green' electricity has an eco-efficiency ranging between the current situation and the other two options.

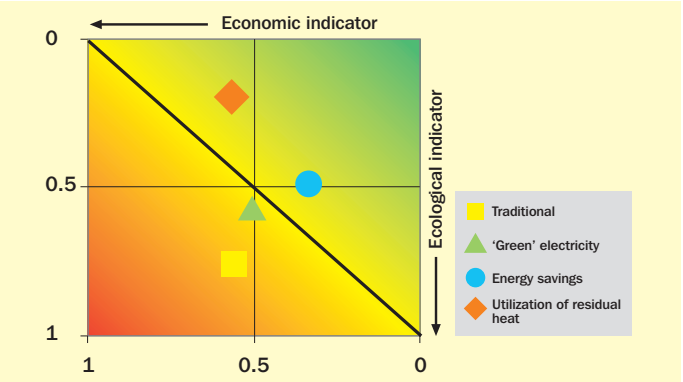


Figure 6 Energy savings options for a housing project in Apeldoorn, The Netherlands.

Could the Eco-Efficiency analysis be interesting for you?

With the five examples and the six figures before, we have tried to make the Eco-Efficiency analysis clear to you: how it works and what you can do with it. If you are in for sustainable innovation, the Eco-Efficiency analysis may also be interesting for you.

Where can you use the Eco-Efficiency method?

- At the process level, when changing production processes
- At the production chain level
- In product development
- In system innovation
- In social innovation.

Eco-Efficiency is also a strategic management tool for:

- Communicating with customers
- Providing insight into the opportunities for investors
- Product strategies
- Increased competitivity
- Improved products or materials
- Sales arguments support
- Influencing public opinion
- Redevelopment of local/regional economy
- Infrastructural changes.

It is clear that the Eco-Efficiency analysis is meant for companies, branch organizations, government authorities, consumer and environmental organizations. With the analysis, you can determine whether desired innovations and/or changes actually do fit in with socially acceptable business practices. Comparing an option with alternatives or with the existing situation can provide graphic insight into the advisability of carrying out a specific option.

Innovation options with the Eco-Efficiency analysis

- Process innovation with savings on energy and water
- New product design
- Application of renewable resources
- Substitution of toxic substances
- Introduction of sustainable industrial areas
- Switch to extensive cattle breeding
- Limitations/alternatives for pesticides
- Decentralized sustainable energy supply
- Factory of the future
- Adaptations in transportation of hazardous substances
- Innovation of distribution and logistic processes
- Extraction of drinking water from the sea
- Infrastructural decisions.

Various companies and branch organizations have already taken advantage of the Eco-Efficiency analysis.

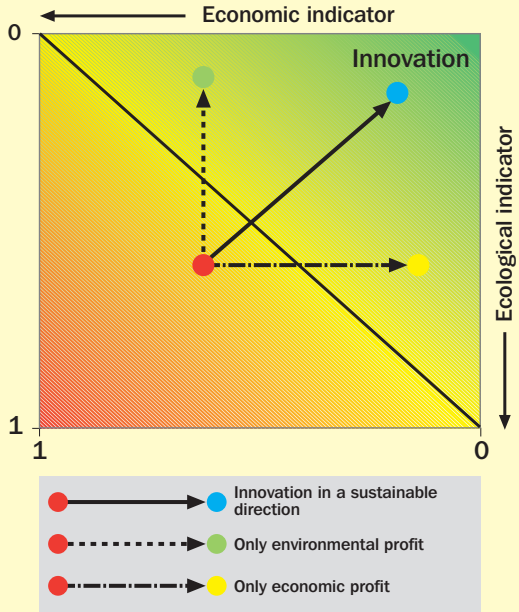


Figure 7 The principle of the Eco-Efficiency analysis employed by TNO.

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Large international branch organizations such as APME (Association of Plastics Manufacturers in Europe) and large companies such as BASF were the first organizations that used the method. However, the method has also proven to be useful for smaller-scale projects such as the one in Apeldoorn.

Is Sustainable Business and Policy a focal point in your business or policy plan and would you like to find out whether the Eco-Efficiency analysis could improve your process, product or strategy?
If so, you're welcome to contact TNO.

Definition of Eco-efficiency

"Eco-efficiency is a management strategy based on quantitative input-output measures which seeks to maximize the productivity of energy and material inputs in order to reduce resource consumption and pollution/waste per unit of output, and to generate cost savings and competitive advantage."

(OESO 1997)