Strengths and weaknesses of eco-efficiency

Jukka Hoffrén

Towards the end of the 1990s, eco-efficiency emerged as a salient new environmental policy perspective, leading to an ever growing number of studies into its development. As the numbers of researchers and studies have increased, their interest is being directed more and more at the usability and limitations of the concept of eco-efficiency and related thinking in diverse analyses and environmental policy decision-making.

Basically, eco-efficiency is an answer to the need of sustainable development to employ quantitative tools and related respective goals compliant with policies. The ultimate aim of eco-efficiency is to achieve significant reductions in the total use of natural resources. According to the laws of physics, the more materials an economy uses, the more pollution and waste it generates. Development of technologies that spare natural resources helps to diminish this generation of waste and pollution. The objective in eco-efficiency is to create more out of less so that the standard of wellbeing remains at least at its present level at the same time as environmental impacts are reduced. Eco-efficiency also offers clear quantitative measures and targets for the attainment of this goal.

Almost all industrialised countries, including especially the European Union and Japan, have been interested in promoting the utilisation of results from eco-efficiency studies at different levels of the economy. According to the EU's eco-efficiency initiative, for example, the productiveness of natural resources should be raised tenfold from its present level over the next 30 to 50 years (Factor 10 objective). Achievement of fourfold increase in the productiveness of natural resources over the next 20 to 30 years is viewed as an interim objective (Factor 4 objective). This way, burdening of the environment could be brought to a sustainable level. Factor 2 has been set as the objective for increasing the eco-efficiency of the national economy over the 1994-2020 period in Germany and Japan is aiming towards a 40 per cent improvement in eco-efficiency between 2000 and 2010.

Eco-efficiency as a route to sustainable development

Eco-efficiency thinking sets out from the premise that adverse environmental consequences can be prevented in advance by reducing the use of materials and energy. The belief behind this is that when a production technology is known, the extent to which it will burden the environment will actually be decided when natural resources and energy are extracted into the economy. The aim is to make environmental efficiency, i.e. eco-efficiency, a central theme alongside economic efficiency. In fact, the concept of eco-efficiency combines sparing use of natural resources, reduction of environmental pollution and economic efficiency, the aim being reduced used of natural resources in order to alleviate harmful consequences form overburdening of the environment. In addition to the eco-efficiency of materials, the focus of research in this field has recently also broadened to environmental policy, technological innovations, welfare, case studies of business enterprises, environmental management systems and environmental programmes of enterprises, as well as to the construction of monitoring systems.

Eco-efficiency thinking is a multidisciplinary approach combining existing thoughts from, among other things, technology, economics, natural sciences and behavioural science. At the moment the approach is dominated by practical application. Eco-efficiency combines basic laws of thermodynamics concerning technology, flows of materials and energy measured by industrial ecology, welfare economics, theories defining a system, biology determining the renewal and carrying capacity of nature and management theories applicable to the targets and management of eco-efficiency. Eco-efficiency thinking has also been influenced by material flow accounting, sustainable development policies and achievements of the Rio Conference on Environment and Development. According to the originators of the idea of eco-efficiency, Schaltegger and Sturm, eco-efficiency is the ratio of desired output to one added unit of environmental impact. Later, the World Business Council for Sustainable Development (WBCSD) favoured the idea that eco-efficiency is achieved through the supply of competitively priced products and services so that human needs are satisfied and the quality of life is guaranteed while at the same time the ecological effects during the production lifecycle and the resource-intensity of products are increasingly lowered at least to the estimated level of the carrying capacity of the globe.

Shifting the attention in social policy from the conventional areas of environmental protection, pollution and wastes to the consumption of natural resources has been slow and laborious, even given the complementary perspective eco-efficiency opens to the policy of sustainable development. As such, eco-efficiency does not measure the effects of small amounts of extremely harmful or toxic substances. While the total consumption of materials is monitored and managed through eco-efficiency, their special characteristics must be considered in other areas of environmental policy.

Weaknesses of the analysis

In essence, the weaknesses of eco-efficiency arise from its multidisciplinary theoretic basis, the nature and uncertainties of environmental problems, and other measurement difficulties. The main weaknesses of eco-efficiency derive from:

- Defining the carrying capacity of a system
- Setting of quantitative targets
- Scale problems of economy
- Difficulty of its popularisation.

According to a number of studies, the basic reason for environmental problems is that man squanders natural resources beyond nature's renewal capacity. It is obvious that the globe cannot carry today's kind and magnitude of economic growth forever. Besides the difficulty of determining the carrying capacity of the globe, agreeing the political level at which quantitative targets should be set for development is also a problem from the point of eco-efficiency. Therefore, eco-efficiency can easily just remain an indicator of the direction of desired development without a connection with activities in the real world. Moreover, problems in defining a system mean that evaluations of the eco-efficiency of an individual process are rarely comparable, and hence carry little weight.

Closely linked with eco-efficiency is also the so-called scale problem of economy, meaning that expansion of the world economy cancels out the positive effects of technological progress. In consequence, the total amounts of pollution and waste would continue to grow even if improved eco-efficiency were to lower the environmental hazards generated per one unit. The basic idea of eco-efficiency, i.e. that an economy is progressing along eco-efficient lines when it produces for its

members a standard of welfare that is at least equal to or higher than at present while using ever-decreasing natural resources and energy, is a necessary but not sufficient precondition on sustainable development. Indeed, this scaling problem of economy is one of the main challenges for eco-efficiency.

Among the reasons why popularisation of eco-efficiency is difficult are that the related thinking is not well known and is based on engineering reasoning, and that relative measurement scales are used in eco-efficiency analyses. The use of diverse summed up data as approximations of environmental impacts is also often viewed as problematic. A further difficulty in assessing eco-efficiency is that both inputs and outputs can be substituted with other inputs and outputs. Indeed, popularisation of eco-efficiency often requires the use of other, supporting measures. Other new environmental indicators, such as ecological footprint and rucksack are usually more illustrative in this respect.

Strengths of the analysis

At the level of an economy, eco-efficiency provides a promising approach that combines the goals of environmental and economic policies for the accomplishment of sustainable development. Practical applications of eco-efficiency thinking at the level of national economies open a number of new perspectives on the physical basis of society and its welfare generation processes. Further strengths of eco-efficiency are that it:

- Provides a clear action strategy for a policy on sustainable development
- Conforms with today's economic system
- Complement's today's economic monitoring and controlling systems
- Is a tool for experts.

One strength of eco-efficiency is that it provides a clear operational action strategy for a policy on sustainable development, as well as a variety of indicators of its direction. Eco-efficiency is not a replacement for today's environmental protection measures, but supplements the picture of the total sustainability of different activities. Eco-efficiency also conforms with today's economic system, and can be utilised to develop present economic monitoring and controlling systems to take environmental effect into consideration. However, making the eco-efficiency perspective easily understandable and meaningful to the public at large and within political decision-making is difficult, as its approach deviates significantly from the empirical world of ordinary people. Thus, eco-efficiency may easily remain just a tool for experts. On the other hand, eco-efficiency analysis is best suited for evaluating the internal efficiency of diverse economic processes and as a tool for experts.

Uncertainties related to the measurement of eco-efficiency

Efficiency, as well as eco-efficiency, is usually expressed as a ratio between output and input. The challenge is finding the right input and output indicators for the measures of eco-efficiency. In practice, examinations of eco-efficiency use indicators of produced welfare as numerators (output) and total environmental impacts as denominators (input). From today's perspective, the main strength in the monitoring of eco-efficiency is that it does not price environmental impact with disputed methods. However, the problem is that exhaustive measurement of such concepts as "welfare", "improved quality of life" and "total environmental impact" with quantitative methods

and combining the obtained data into an overall indicator can easily entail an excessive amount of work and often also subjective assessments. In practice, examinations of eco-efficiency must often resort to indicators that depict phenomena only very roughly. The challenge is to find output and input indicators that describe phenomena accurately and exhaustively. Indicators of eco-efficiency are also relative ones and, thus, at their best in pointing the direction of development. Evaluations of the benefits from an activity are made difficult by price fluctuations which may cause major variations in the trends of eco-efficiency. Evaluation of eco-efficiency is also difficult because both inputs and outputs can be substituted with other inputs and outputs.

Total material requirement (TMR), direct material input (DMI) or a weighted measure of total environmental hazards can be used as approximations of total environmental impact. However, in practice calculations of total environmental impact require the use of various weighting coefficients in respect of the environmental impacts that are regarded as primary. Calculations of total environmental impact at the level of the whole economy can easily become so complicated that the results will no longer be usable relative to the gained benefits. Exploitation of total material use is hampered by uncertainties connected with the monitoring of hidden flows. This is why the most frequently used measure is direct material input (DMI), on which fairly reliable time series are available for certain national economies, sectors and even enterprises.

In conclusion

In recent years, the application of eco-efficiency thinking has been increasing among national economies and enterprises, although its wider diffusion is being hampered by lack of standardised instruments for the measurement of sustainable development and universally agreed quantitative targets. Often, eco-efficiency indicators also give only a rough picture of the development of environmental impacts, which fails to satisfy experts striving for precise interpretations. By its nature, eco-efficiency aims towards general sustainability of activity, meaning that it often gets overshadowed by specific, urgent issues of the day. Thus, it would be important to establish how eco-efficiency could be developed and operationalised as part of the everyday activities of an economy, its sectors and enterprises in a standardised manner that would lead to the accomplishment of eco-efficiency targets alongside other daily activities.

At the global level, modes of production and consumption should be sought that are based on sustainable material and energy flows. Change towards more sustainable development should be expedited by improving the eco-efficiency of production as well as by e.g. putting prices on environmental hazards. Such hazards can be taken into consideration more comprehensively than before in decision-making by increased used of environmental taxation so that the environmental hazards generated by production can be brought down.

For Finland, eco-efficiency is a major challenge because Finnish economy was largely built on intensive use of natural resources. The economy has only been uncoupling from the consumption of materials in recent years. Up to now, environmental protection and reduction of emissions have happened almost entirely due to individual technical solutions instead of comprehensive monitoring, control and rationalisation of the use of material flows. Economic steering instruments have also not been exploited as yet although they would be an efficient means for increasing technological innovations and their introduction into practice. For the moment it seems that the breakthrough of eco-efficient thinking is lagging well behind other industrialised countries in Finland. Nevertheless, assuming a pioneering role in this is still quite possible and even necessary for the future of society.