

# Eco-efficiency

## Philosophy, Theory, and Tools

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It is ironic that I am writing this column on the philosophy, theory, and tools of eco-efficiency, because I expressed my skepticism concerning the subject at the meeting that is the source of this special issue. The concept of eco-efficiency was first described by Schaltegger and Sturm (1989) and then widely publicized in 1992 in *Changing Course* (Schmidheiny 1992), a publication of the World Business Council for Sustainable Development (WBCSD). Since then it has been accepted as the key strategic theme for global business in relation to commitments and activities directed at sustainable development. The WBCSD describes eco-efficiency as “being achieved by 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 concept’s practical and theoretical importance lies in its ability to combine performance along two of the three axes of sustainable development, environment and economics. Issues concerning equity and other social properties are not included in the concept of eco-efficiency. The notion that increasing economic development would have to be correlated with lowering of environmental impact is not a new concept. This relationship was first popularized through the so-called IPAT identity. Invented by Ehrlich and Holdren in the early 1970s, the relationship im-

plies that to hold or reduce environmental impact (I) as population (P) and affluence (A) increase, technology (T) would have to become dematerialized (Ehrlich and Holdren 1972). Later, environmental scholars spoke of Factor 4, Factor 10, or more as estimates of just how much dematerialization would be needed to offset economic and population growth (Reijnders 1998).

This broad description conveys the general thrust of the concept but offers no specifics as to how to reduce it to practice. The First International Conference on Quantified Eco-efficiency (Leiden), in 2004, which is the source of this special issue, highlighted this lack in its focus on providing quantitative interpretations of and methods for eco-efficiency.

Eco-efficiency is fundamentally a ratio of some measure of economic value added to some measure of environmental impact. The higher the value added, the more efficient is the use of environmental services. Alternately, some invert the ratio, which then generally becomes known as eco-intensity. Marginal values may be used to determine relative performance among alternatives. The number of possibilities associated with the term hints at one of its problems—simply understanding what is being discussed under the rubric of eco-efficiency. But this problem, which can be handled by careful communication, pales in relation to the next: quantification.

I use quantification broadly as the process of choosing and enumerating the expressions that will become the numerator and denominator of the ratio. Both are problematic. Computing the denominator (environmental impact) faces the same issues that are common to life-cycle assessment or any other environmental assessment

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methodology: What impacts should be included, what boundaries are appropriate, what output metrics should be used (mass, effects measures, values), and so on.

The economic expression is somewhat less controversial, although not without problems. Some are analytic and others normative. Because sustainable development is about both human welfare and justice, one needs to ask whether a measure that is limited to the neoclassical notion of aggregate social welfare is consistent with this overarching context. Even if the answer is yes, the question of the validity of standard measures of welfare remains. How should the contribution of a firm be computed? The usefulness and acceptability of eco-efficiency is now and likely will continue to be buffeted by the same arguments that have affected the acceptability and legitimacy of both the numerator and denominator.

This issue cannot be resolved without examining the way the results of eco-efficiency calculations are interpreted and applied in practice. The Conference speakers pointed to several potential uses. The main possibilities are as follows:

- Choosing among alternative processes and products (microscale);
- Evaluating the performance of a company or other organizational entity;
- Evaluating the performance of a country, region, or other macroentity.

The chemical product company, BASF, uses a simple form of eco-efficiency to choose among alternative processes and options. By plotting the cost (or value) and impact relative to a “reference” process/product on a two-by-two grid, those options that produce gains in both dimensions are easily distinguished. This simple tool and similar variants are very useful for strategic decisions within a firm, but are only loosely connected, if at all, to global improvements consistent with the limits driving other related concepts such as Factor X.

The same can be said of macrolevel applications of eco-efficiency. Eco-efficiency can be used to examine alternative governmental policies in the same way that companies rate product alternatives. It can also be used to characterize the performance of an economy by adding up the aggregate social welfare or value added and dividing

by the total environmental impact. This procedure may be useful in comparing one nation or company to another, but again tells little about the direction of progress toward the goal of sustainable development. And again the shortcoming has both a practical and a theoretical basis.

Enumeration at this level necessarily requires aggregation and simplification, which are strongly value-driven processes, but technicians generally determine eco-efficiency, working without any public input into the determination of what values are appropriate. Also, as I mentioned already, there is great controversy over the validity of standard social welfare functions (GDP, for example) and product (value added) or process (total cost accounting) formulas. Methods are approximate and in practice suffer from limited availability of data. They tend to be complex and lack transparency, so that the result of their use is difficult to communicate to the public and even to key decision makers.

But a more important question always lurks in the background. Eco-efficiency is a notion that is meaningful only in the context of the economic model of sustainable development. Although the WBCSD’s statements indicate that production output should be kept “in line with the Earth’s carrying capacity,” there is nothing in the analytic representation of eco-efficiency that provides a clue to this. Standard economic theory assumes that limitless resources will always be available as scarcity incentivizes sufficient innovation to produce substitutes. Carrying capacity simply does not enter the economic calculus. The present, clearly unsustainable state of the world trumps this theory, rendering eco-efficiency only a partially useful concept.

Notwithstanding this limitation, more eco-efficient choices are always to be preferred over poorer choices, and in this sense eco-efficiency can be a useful tool for strategists and policy makers. On the other hand, its casual use can become seen as the “solution” to unsustainability (as business seems to be saying), shifting the burden (in the language of systems dynamics) away from the search for effective solutions. Better choices among a set none of which are good enough are fools’ choices.

Maintaining sustainability, for example, in terms of not exceeding carrying capacity, in an

absolute, global sense is the goal, even of a process model such as sustainable development, in which this explicit goal is implicit. If eco-efficiency is to become a useful indicator for determining choice, it must be coupled with other indicators and tools. Even the direction of change toward sustainability would be negative if increases in eco-efficiency were to be offset by larger increases in total output. Current gains in eco-efficiency, according to both corporate and governmental data, are small, far short of the radical jumps consistent with factor X or other models that reflect the Earth's limits. It seems much more compelling that policy and product innovation should seek substitutes that radically reduce the amount of stuff that humans all over the globe use to produce well-being.

## References

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