1 An introduction to quantified eco-efficiency analysis

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1.1 The challenge of sustainability

A growing global population with growing affluence may well lead to reduced environmental quality and a diminishing quality of nature, ultimately jeopardizing the quality of human life and even human life itself. The challenge we face is to reduce the environmental consequences of our actions so as to reduce environmental risks and to retain the quality of the environment not only as is necessary for survival but also reflecting higher order values on nature and human life, as for example reflected in the concept of sustainability. The challenge has down to earth properties. Environmental impacts per unit of welfare, as eco-efficiency, on average should be appropriate for sustainability. Simplifying the analysis a bit, as by disregarding non-linearities and dynamics, in any year the total amount of environmental impacts should be within limits as set by sustainability considerations. In any one year this total amount is the sum-total of all micro-level economic actions in production, consumption and waste management, including investments and public sector activities. These economic actions grow in real terms, for the decades to come may be by four percent per year. Therefore, the eco-efficiency requirements on global society as a whole somehow have to be matched by eco-efficiency requirements on all our activities to counteract such expected growth. They should be reflected in all our economic decisions.

G. Huppes and M. Ishikawa (eds.), Quantified Eco-Efficiency, 1–38.

There is no direct correspondence to micro level actions and decisions, however. The average macro level environmental burden per unit of expenditure, actual or allowable, cannot be matched with environmental impact per unit of value added in a micro level activity. Some activities by nature can be virtually without environmental impact, as in many cultural events like singing classes or mathematics studies. Other activities, like international travel and coal mining, have a high impact per unit of value added by shear technical necessity. Putting the same eco-efficiency requirement on all activities as is valid on average at a macro level clearly is not possible. Still, in order to reach the required eco-efficiency at macro level, that is the sum of our micro level actions in terms of value and environmental impact, there should be requirements on individual activities and decisions. Before engaging in the difficult and by nature political process of *who should do what* to safeguard our future, we first should know the empirical facts and developments: what is the eco-efficiency of our current activities, how do they develop and which options for further improving eco-efficiency do we have. Though statistically the macro level just is the sum of all micro level activities, the link to decision making is not so clear. Individual economic actions are not created in a void but are intricately related. Reducing emissions at one spot may well lead to more than compensating increases in other spots, as might be the case with bio-ethanol from grain in gasoline (Farrell et al. 2006). Production and consumption chains, and their waste management requirements, are intricately related and may cover many years as with investment goods and durable consumer goods. So the unit of decision making cannot just be individual activities, as their interrelations have to be taken into account. This leads to modeling of interrelations in developing product systems, of firms behavior, of regions and countries, with all complex feedback loops as are present in society. Eco-efficiency analysis of decisions depends on such models, simple or complex. Only for monitoring purposes, eco-efficiency analysis does not pertain to effects of decisions and actions, but to the environmental impacts and value created by activities which can be added to a yearly total for the world. The units to add up ultimately are single activities, however defined, and aggregates of these. Examples are firms; private consumption households; sectors; regions; and product systems. Only for very simple models the link to the macro level is relatively direct, as with environmentally extended input-output analysis. Also steady state type LCA is close,