Can Cleantech contribute towards a sustainable future?

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Abstract

Cleantech can be described as a diverse range of products, services or processes using technologies that optimize our use of natural resources and minimize environmental impacts. In this paper we explain that Cleantech can be seen as an implementation towards (weak) sustainability. This because proponents of weak sustainability believe that technological improvement can overcome any resource constraint. Cleantech can contribute towards a sustainable future but Cleantech is not the equivalent of a sustainable future because Cleantech activities do not solve the question of absolute scarcity. On the other hand, Cleantech can be an important step if we move from system optimization towards system innovation and transition. To achieve maximum diffusion and valorization of environmental technologies, we therefore distinguish the “Cleantech approach”. In this value-oriented approach all Cleantech key players (companies, research centres, consumers, government and investors) search for value in a spirit of cooperation.

Introduction

Economic development has by definition negative externalities; e.g. pollution, emissions of greenhouse gases and waste production. Environmental damage and deterioration in natural resources call for new concepts for the future of (industrial) society. We need a production and consumption model that is able to reduce our use of natural resources and to avoid pollution to the maximum extent possible. In other words, it is necessary to sever the link between economic, social and environmental aspects. Hence, we need sustainable development. In this paper, we will discuss the meaning of Cleantech and place Cleantech next to sustainability. Therefore, we will first specify what we understand by Cleantech. Further, we will define sustainability and describe different notions of sustainability (weak versus strong sustainability). Finally, we discuss the value-oriented approach of Cleantech as a possible solution towards more sustainable development.

Cleantech

In fact, Cleantech is short for Clean technology. Cleantech generally refer to a diverse selection of products, services or processes using technologies that optimize our use of natural resources and minimize environmental impacts. Examples of environmental impacts are GHG emissions and wastes. The use of renewable materials and energy sources is an important aspect to optimize our use of natural resources. Pernick and Wilder (2007) stress the fact that Clean technology deliver equal or superior performance compared with conventional offerings.

Definitions of sustainability

As in each text about sustainable development, we will start with the most known definition of sustainable development:

Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

This definition can be seen as the standard definition when judged by its widespread use and frequency of citation (Kates et al., 2005). Although this Brundlandt definition captures the essence of sustainable development, it is hard to use in economic analysis because of the difficulty of the concept of need (Pezzey, 1992a). In his definition of sustainability, Pezzey (1992b) tries to relate most aspects of sustainability to the economic concepts of production functions and utility functions:

Sustainability is non-declining utility of a representative member of society for millennia into the future.

Neumayer (2003) proposes a definition that leaves space for free choice:

Development is sustainable if it does not decrease the capacity to provide non-declining per capita utility for infinity.

This last definition is not utility (in contrast with the Pezzey-definition), because here sustainability is defined in terms of maintaining the capacity and not the utility itself. One finds a variety of definitions, meanings and interpretations (Perman et al., 2003). Hence, it is clear that there is no universally agreed definition of the concepts of sustainability. As a consequence, some scholars forecast that the notion of sustainable development will remain fuzzy, elusive and contestable (Levin, 1993; Beckerman, 1994; Dasgupta and Mäler, 1995). On the other hand, Bell and Morse (1999) argue that the flexibility of the meaning of sustainability can be a great strength in a diverse world. In fact, sustainable development draws much of its resonance, power, and creativity from its very ambiguity (Kates et al., 2005). An important aspect of the application of sustainability is the emphasis on multidimensionality (economic, social and environmental issues). Furthermore, sustainability can be recognized on multiple layers ranging from supra-national (e.g. world, E.U.-level), national, sectoral and firm level (Bebbington et al., 2007). Hence, the achievement of sustainability requires an effective integration of multiple levels and systems that are nested in space and time (Starik and Rands, 1995; Pearson, 2003). Finally, sustainability can be described as a dynamic process of sustainable quality improvement (Lawn, 2001). In this context, one is transforming a system that was previously unsustainable into one that is at least relatively sustainable (Barbier, 1987). Examples are approaches that see the way towards sustainability as a step or stage process (e.g. Pretty, 1998; Hill et al., 1999; Kuhndt and Siefert, 2004) or as a transition process (e.g. Nevens et al., 2007).

To summarize, we often find one or several of the following concepts in the description of the numerous notions of sustainability: (i) natural resources are finite and there are limits to the carrying capacity of the Earth's ecosystem, (ii) economic, environmental and social goals must be pursued within these limits, (iii) there is a need for inter- and intragenerational equity (Farrell and Hart, 1998).

Different notions: weak versus strong sustainability

Within economics of sustainability, two main opposing paradigms of sustainability can be distinguished. The mainstream neoclassical view has come to be known as weak sustainability. This view states that substitutability of human-made capital for environmental resources is more or less unlimited, while proponents of the strong sustainability view find that capital-resource substitutability is either a self-evidently impossible concept, or subject to strict and fairly imminent limits. Note that weak and strong views are really views about the fact of substitutability and not about the goals of sustainability (Pezzey and Toman.2002). Apart from the assumption about the degree of substitutability, a second important offsetting force to the limits to growth, introduced by the presence of exhaustible resources, is that of technological change (Cabeza Gutés, 1996). Weak sustainability is a paradigm of resource optimism. Therefore, Neumayer (2003) calls proponents of weak sustainability environmental optimists. Those neoclassical economists assume that every technology can be improved upon and every barrier can be surmounted or broken through (Ayres, 2007).Hence, technological change can result in an increase of efficiency and can either reduce or replace the inputs necessary to produce goods and services. In this way, technology makes it possible to exceed the material limits of natural resources by substituting inputs if resources are depleted or if productivity limits are reached (O'Hara, 1998). Hence, proponents of weak sustainability belief that any natural resource can be substituted by another resource, or by man-made capital, or by technical progress, or by some combination thereof.

On the other hand, proponents of strong sustainability argue that even continuous technological change will not change their pessimistic outcome (i.e. future consumption will finally fall to zero). Several reasons justify warnings against an overly optimistic view (Vollebergh and Kemfert, 2005). First, not all our environmental resources can be preserved equally effectively by technological change (for example our consumption of nature and its associated environmental good biodiversity). Second, sometimes more radical changes are needed, and these fundamental changes require a transition of a whole system. Third, learning-by-doing is not entirely free, diffusion of knowledge can be costly and our understanding behind this process is rather limited (Vollebergh and Kemfert, 2005). Finally, with respect to the role of technological change in discussing sustainability several questions arise (Ayres et al., 1996): (i) the problem of empirically distinguishing between the substitution among resources within a given technology and technological change; (ii) will technological change follow the right direction?; and (iii) the fact that the positive effect that technological change might have in offsetting the limits to growth by exhaustible resources cannot by analyzed without considering the negative feedback that the new technologies might have on the environment (Cabeza Gutés, 1996). These arguments temper the technological optimism of adherents of the strong sustainability view.

Neumayer (2003) concludes that both paradigms are non-falsifiable under scientific standards. Both rest on certain assumptions, hypotheses and claims about the future that are non-refutable. Therefore, Ekins et al. (2003) finds that the choice between weak and strong sustainability should be an empirical rather than a theoretical or ideological matter. Similarly, Pezzey and Toman (2002) state that: *Up till now, the weak sustainability view of substantial substitution and innovation possibilities seems to have been borne out by history. Whether it will be in the far future remains an open empirical question that will require big advances in data and methodology to answer*.

Hence, the pessimistic predictions might have failed because the concern has forced people to react in time and develop better technologies and social institutions. Furthermore, Neumayer (2003) states that to conclude that there is no reason to worry, because the pessimists have been wrong in the past, is tantamount to committing the same mistake the pessimists are often guilty of, that is the mistake of extrapolating past trends. In the future, problems (e.g.,environmental problems) may take completely new and surprising forms. To solve these problems (towards more sustainability), not only advances in data and methodology but also an open-minded cooperation between different sciences such as ecology and economics will be required (Tahvonen, 2000).

Note that the present distinction between strong and weak sustainability is illustrative but not complete. In fact, a more disaggregated view on resources, technological progress and substitutability and complementarity is advisable. Furthermore, equity concerns (inter and intragenerational) are not considered in the discussion about resource substitutability but they are also essential for a sustainable development. Nevertheless, the described conceptual framework (weak versus strong sustainability) can serve as a guideline to discuss the meaning of sustainability.

Cleantech and sustainability

It seems obvious to see Cleantech as an implementation towards (weak) sustainability. Proponents of weak sustainability believe that technological improvement can overcome any resource constraint. Clean technologies such as solar energy, wind power, biofuels, green buildings and water filtration make it possible to exceed the material limits of natural resources by substituting inputs (e.g. wind or solar for coal or oil). It is our opinion that Cleantech is an important significant step towards sustainability that must be taken along the road leading to a stronger sustainability. Cleantech companies can contribute towards both more sustainable production and consumption. Cleantech is necessary for an optimal allocation of our resources but optimal allocation of a given scale of resource flow within the economy is one thing, while optimal scale of the whole economy relative to the ecosystem is an entirely different problem: Optimally loaded boats will sink under too much weight, even though they make sink optimally! (Daly, 1991b). Hence the market is very effective at revealing relative scarcities but (strong) sustainability is also a question of absolute scarcity. This “scale-issue” is not solved by developing clean technologies. That’s why Cleantech can contribute towards a sustainable future but Cleantech is not the equivalent of a sustainable future.

Cleantech can be an important step if we move from system optimization towards system innovation and transition. To achieve sustainability, fundamental changes are needed. In fact, the realization of sustainability can be seen as a process of social innovation (Rotmans, 2005). Substantial improvements in sustainability performance, may still be possible with innovations of an *incremental* kind (Geels et al., 2004), this can be called system optimization. Larger jumps in sustainability performance may only be possible by system innovations. Transition can be defined as a profound process of change on different social levels in the long run. Historical examples include: (i) from hunting to agriculture, (ii) from sailing ships to steamships, or (iii) from mechanics to informatics. The transition towards sustainability is somewhat different because there is a clear postulated target. The transition from one socio-technical system to another can be called system innovation, which is wider than product and process innovation. Such a system innovation is required for a successful transition to a sustainable system. A transition is complex, drastic and takes time. Moreover, there is also a lot of uncertainty. In the short term existing system are adjusted and improved (system optimization), in the long term existing systems are changed in totally new systems with new functions (system innovation).

Cleantech concept and the Cleantech approach

However, Cleantech may not be used as a new buzzword without a real change of minds. Moreover, if anyone can redefine and reapply the term to fit to their purposes, it becomes meaningless. Therefore, it is essential that Cleantech is accurate described. Therefore we define Cleantech as all products, services or processes using technologies that optimize our use of natural resources and minimize environmental impacts. As explained by Pernick and Wilder (2007) nuclear power cannot be described as Cleantech, because this technology does not minimize environmental impacts by producing radioactive waste disposal. The lack of GH emissions of nuclear power is (at this moment) out weighted by the negative (environmental and social) impacts and the uncertainty of the radioactive waste disposal and storage.

Traditionally, environmental technologies were developed to solve existing environmental problems or to meet environmental standards (end-of-pipe technology). Cleantech can be seen as the next step where technologies are used to create added value hand in hand with environmental surplus. Cleantech is developed to solve existing environmental problems but also to prevent future environmental problems. Both the technological push as the demand pull (market approach, government intervention,…) are important. Especially the market approach is an essential aspect of the development of Cleantech. Government intervention is also important to stimulate Cleantech but it is not anymore the only factor.

To summarize, we can describe the “Cleantech concept” as a diverse range of products, services or processes creating economic value together with an optimal use of our resources and with a minimal environmental impact. Besides the “Cleantech concept”, we also distinguish the “Cleantech approach”.

Economic activities cause environmental costs. Problems arise if these environmental costs are external, called externalities. An externality exists whenever the welfare of some agent, either firm or household, depends not only on his or her activities, but also on activities under the control of some other agent (Tietenberg, 2003). Moreover, externalities are a normal, inevitable part of the consumption and production process (Ayres and Kneese, 1969). As a consequence, it is the responsibility of the government to solve the environmental issues by internalizing the external costs (e.g. pollution taxes, environmental standards). As a result, companies search for solutions to meet the requirements of the government (or society). To develop environmental solutions companies can possibly involve research centres (e.g. universities or specialized companies). These successive steps are depicted in the following elementary figure (figure 1). We describe this approach as the burden-oriented approach.

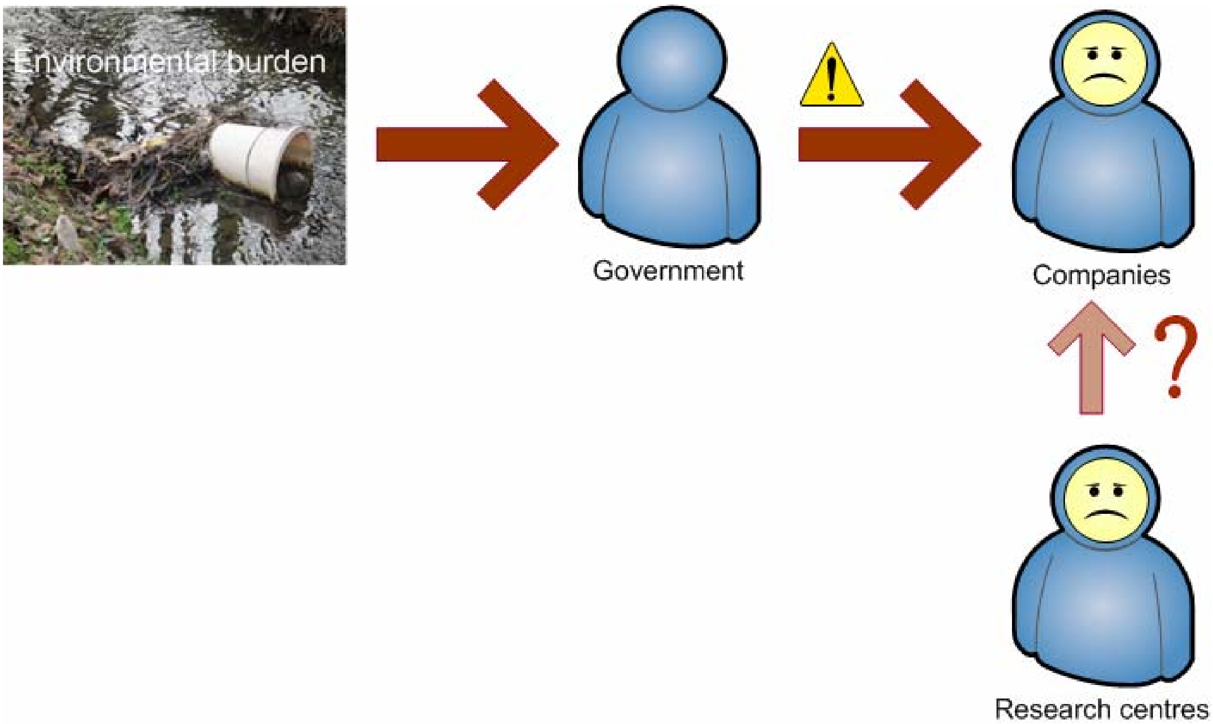

Figure 1: the burden-oriented approach

In general the burden-oriented approach does not result in innovative and proactive environmental solutions. The lack of cooperation between the different actors or key players (government, companies and research centres) impedes a maximum diffusion and valorization of environmental knowledge. That’s why we introduce another approach, described as the Cleantech approach. We refer to this approach as the value-oriented approach because all key players search for value in a spirit of cooperation. We distinguish five different key players: (i) Cleantech companies, (ii) Research centres, (iii) Cleantech consumers, (iv) Government, and (v) Cleantech investors. The Cleantech approach is depicted in figure 2.

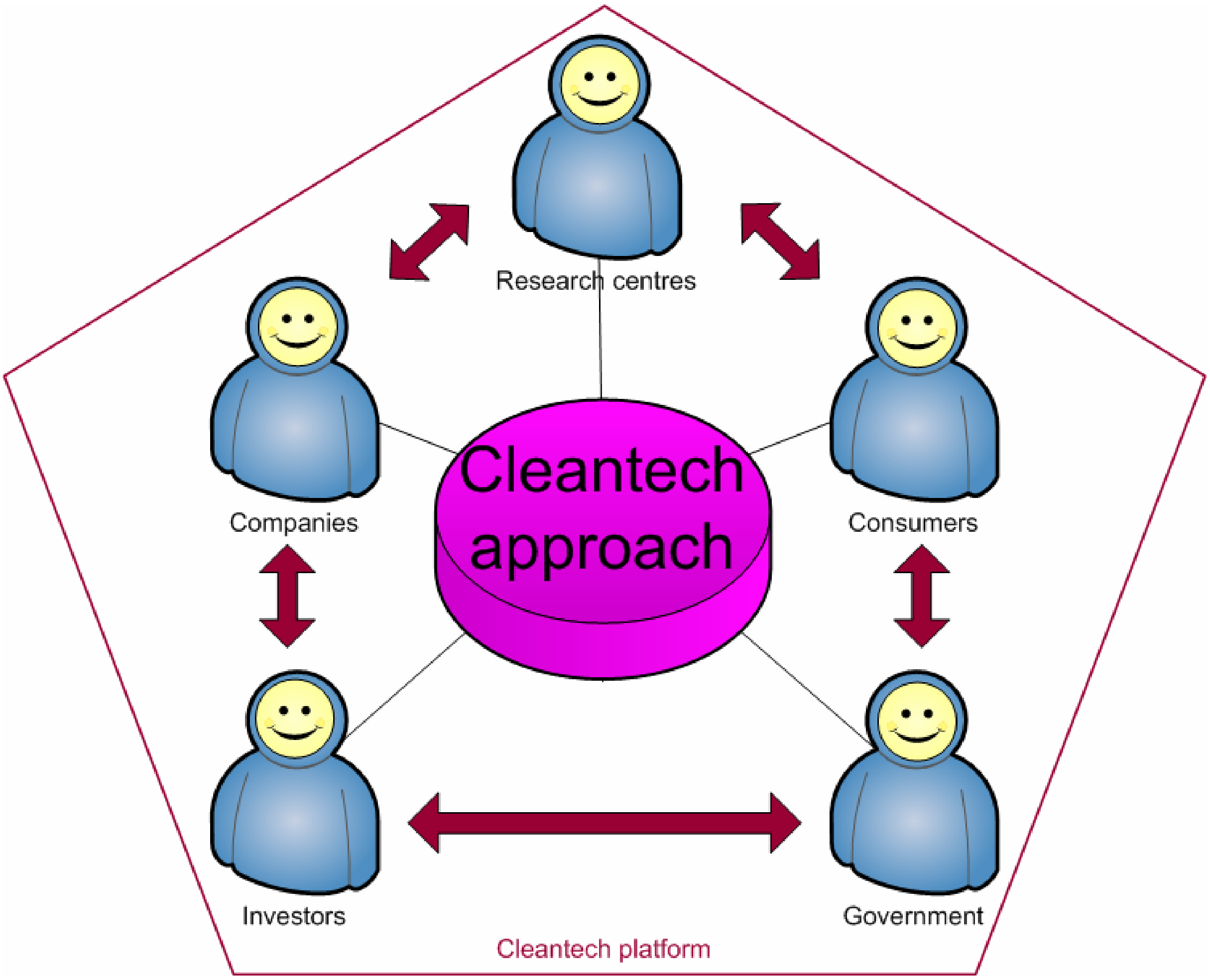

Figure 2: The Cleantech approach or the value-oriented approach

Cleantech companies develop innovative environmental solutions. Important is the cooperation with research centres because in this way environmental knowledge can be valorised into economic and environmental value. Cleantech companies need money to develop and commercialise their environmental solutions. This can be provided by Cleantech investors (e.g. venture capital funds, public funds). As mentioned earlier the demand pull is important, Cleantech consumers determine if the valorisation of environmental solutions will succeed or fail. Possible Cleantech consumers are companies, private persons and the government. Also the government is an important Cleantech key player. The government can stimulate economic Cleantech activities (i) by supporting the development of Cleantech research, (ii) by providing subsidies for Cleantech companies, (iii) by purchasing environmental products or services (e.g. solar cells on government buildings), (iv) by sensitizing possible consumers for Cleantech, and (v) by elaborating a legal framework. The interaction and cooperation between the different Cleantech actors is important and essential for innovative and sustainable solutions. In practice, a Cleantech platform is necessary to stimulate and organise interaction between all relevant Cleantech key players. Such a platform includes all aspects of the Cleantech toolkit suggested by Pernick and Wilder (2007): (i) access to capital, (ii) R&D support, (iii) workforce talent and (iv) supportive policies.

While environmental impact presents clear challenges and costs to our economy, it also presents opportunities. Markets for clean technologies are set for a prolonged period of rapid growth (Stern, 2006). To take full advantage of the growing clean technology market, we need to understand the interlinkages between all Cleantech key players or actors. The suggested Cleantech approach can help to design policy and strategy (of profit and non-profit actors) in a way that minimizes the area of conflict between goals, and to reap the benefits of the opportunities.

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