International Conference « Science for a Sustainable Society »
Workshop 1: Sustainable Industrial Development
Roskilde, 27-29/10/97

PVGV/4.09.97

Science, Technological Innovation and Sustainable Development

Gérard Valenduc, Patricia Vendramin
Fondation Travail-Université (FTU)
Namur, Belgium

This paper attempts to discuss the relationships between the concept of sustainable development and the practice of scientific research, technological innovation and industrial development. It is based on both completed and ongoing studies of science, technology, environment, development and employment at the Work & Technology Research Unit of the Fondation Travail-Université (1).

First of all we discuss the different conceptual interpretations of sustainable development among the scientific community. Afterwards we use the epistemological concept of *research traditions* in order to explain this diversity of interpretations and its impacts on the prospects for technological development. As a third step we develop an approach to *sustainable technology* and show why such an approach requires more interdisciplinary research. In conclusion we summarise some options and questions about interdisciplinarity in these areas.

1. Science, Technology and the Concept of Sustainable Development

1.1. The Conceptual Diversity

Other authors in this area have already pointed out the high degree of diversity in the definitions and approaches to the concept of sustainable development. In this paper we will start from a very basic conceptual framework drawn from common characteristics in the definitions given by the institutional reference documents, such as the Brundtland Report, the Agenda 21, the Action Plan of the

---

(1) A report on scientific research and sustainable development, for the Belgian Federal Science Policy Office:
- Valenduc G., Vendramin P., Marion J-Y. (FTU), Berloznik R., Vancolen D., Van Rensbergen J. (VITO), *Développement durable et recherche scientifique*, Services Fédéraux des Affaires Scientifiques, Techniques et Culturelles (SSTC/DWTC), Bruxelles, 1996. Also available in Dutch.

An exploratory study of innovation, environment and employment, for the Regional Ministry for Research and Technological Development:
- Valenduc G., Vendramin P., *Le travail au vert – environnement, innovation et emploi*, Editions EVO, Bruxelles, 1996. English synthesis published in *TA-Datenbank Nachrichten*, vol. 5 n° 4, ITAS, Karlsruhe, Dec. 1996

An ongoing study of technological innovation fostering sustainable development, for the Federal Science Policy Office, within a pluriannual research programme on sustainable development 1997-2000:
- Vendramin P., *Technological innovation for sustainable development*, in *TA-Datenbank Nachrichten*, vol. 6 n° 2, ITAS, Karlsruhe, July 1997.

European Union, etc. Throughout all these documents, the concept of sustainable development appears to have three basic components:

- the question of ecology, natural resources and global changes;
- the question of solidarity and justice, between present and future generations and between developing and developed countries;
- the question of economic growth and regulation, production and consumption.

These three components are common references in the various approaches to the concept of sustainable development in both political circles and the scientific community. They are not so new, as far as they were already present in the definition of the concept of « eco-development » at the Stockholm Conference, in 1972. Furthermore, those basic components are directly related to a multidisciplinary approach, insofar as they mix natural and social sciences.

The implementation of sustainable development gives a large role to scientific research and technological development. Scientific research always appears as an instrument that can foster sustainable development, as well in the Agenda 21 (chapters 34-35) as in its preparatory documents (ASCEND 21 – Agenda of Science for Environment and Development into the 21th Century) and in the follow-up of the Rio agreements (CSD – Commission on Sustainable Development). Research is presented as a key issue for a better understanding of the problems of sustainable development, as well as a key instrument in the elaboration of concrete measures and in the design of efficient solutions. Science is, however, only one instrument among others, together with regulatory, financial, cultural, institutional and political instruments, from which it cannot be isolated. Beyond this statement, scientists often diverge when they have to make the concept of sustainable development more operational in their research and development activities.

The next section attempts to discuss what kind of factors can explain the diversity in the interpretations of sustainable development among the scientific world and what are their consequences.

1.2. Factors Explaining Conceptual Diversity

Conceptual diversity can be brought back to three factors that make up the difference between the points of view of the various scientific disciplines and the role they attempt to play in sustainable development. These factors are:

- the models for understanding the relations between man and nature;
- the points of view on social relations and on the organisation of society;
- the different cultures and conceptual frameworks coming from the various scientific disciplines dealing with the questions of science and sustainable development (paradigms, research traditions).

For several authors, among whom Renn (2), De Wit and Opschoor (3), conceptual diversity can be characterised by the dilemma anthropocentrism / ecocentrism, allowing three different approaches to the relations between man and nature:

- The « utilitarian » anthropocentric approach considers nature as the main resource for the satisfaction of the needs of human beings. Society has to organise the management of natural resources like « good housekeeping » for the current and future generations, taking into account the limits of regeneration and exhaustion of natural resources. Technology and industrial development have to care for ecological efficiency.
- The « protectionist » anthropocentric approach considers nature as an essential collective good to be preserved as a guarantee for the survival and welfare of human societies. Any technological and industrial progress should respect the fragile equilibrium between human activities and the protection of nature.
- The ecocentric approach considers that nature belongs to all the living beings. Among them, human beings have the particular responsibility for managing their needs and demands according to the requirements of their environment. Human activities have to comply with the ethics of nature, which is of course constructed and interpreted by humans. The ecocentric approach has very little influence on the problems of technology and industry, but intervene in conflicts about environmental protection.

Other authors, such as Riechmann (4), also stress that conceptual diversity is related to ethical choices, but in a different way. Diversity reflects a struggle between opposite interpretations of the term « sustainability ». Some dominant interests in industry and politics try to reduce the original concept of sustainable development to something like « sustained growth », in order to avoid radical changes in the current production and consumption models. Conceptual diversity means political pluralism. Riechmann recognises that there is not a unique « good » concept of sustainability and he pleads for criteria and principles in order to assess to what extent a particular development (technology, industry, law, etc.) is really sustainable.

Although meaningful, this kind of explanation can be applied to all the opinions about sustainability and it is not specific to science and technology. Other factors have to be taken into account. Renn and Kastenholz suggest that the « cultural backgrounds » of the different existing disciplines exert a significant influence on the behaviour of scientists towards the sustainability issue:

- For an economist, sustainability is at first related to new economic models of growth and regulation, taking into account not only the traditional quantifiable components of welfare, but also a lot of environmental « externalities » and qualitative assets.

---

(2) Renn O., Kastenholz H.G., *Ein regionales Konzept für nachhaltiger Entwicklung*, in *Gaia: Ecological Perspectives in Science, Humanities and Economics*, Spektrum Akademischer Verlag, Basel, vol. 5, n° 2, 1996, pp. 88-89.
Renn O., *A regional concept of qualitative growth and sustainabiltity*, Bericht Nr 2, Akademie für Technikfolgenabschätzung in Baden-Württemberg, Stuttgart, 1994.

(3) De Wit A.J.F., Opschoor J.B. (Eds.), *Duurzame ontwikkeling: een verkenning van de consequenties voor wetenschpsbeoefening en onderzoek*, Raad voor Milieu en Natuur Onderzoek (RMNO), Den Haag, 1990, pp. 8-9.

(4) Riechmann J., *Desarrollo sostenible: la lucha por la interpretación*, in *Ecología y Economía*, Fundación Primero de Mayo, Ediorial Trotta, Madrid, 1995.

- For an ecologist, sustainability means the use of natural resources to the extent that the carrying and regenerative capacities of the ecosystems are not jeopardised.
- For a physicist, sustainability means the ability of biological systems to fight against degradation of energy and resources (entropy) by creating new forms of order (negentropy) using the various inputs of solar energy.
- For a chemist or an engineer, the challenge of sustainability is to complete material and energy life cycles created by human activities, through new techniques for material design, re-use, recycling and waste management.
- For a social scientist, sustainability is characterised as « the social and cultural compatibility of human intervention in the environment with images of nature and the environment constructed by different groups within society » (5).

Factors linked with disciplines are also used by Faucheux and Noël (6) when they explain that the evolution of the economic theories on environment and sustainability is strongly determined by paradigms in natural sciences: mechanics, thermodynamics, living systems.

This short overview of explanations of conceptual diversity raises a question: can we consider sustainability as a new paradigm for both natural sciences and social sciences ? This question is not purely academic. If the answer is yes, sustainability should become a conceptual reference framework for all scientific disciplines. If the answer is no, sustainability has a more pragmatic role: it provides all sciences with a series of purposes, problems, questions, controversies and challenges that must require new methods and new solutions.

We think that the paradigmatic approach, in the Kuhnian meaning (The Structure of Scientific Revolutions), is not really appropriate to sustainable development. According to Kuhn, a new paradigm has to replace the old one, after a period of conflicts within scientific institutions, due to unsolved anomalies in the old paradigm. Such a linear model is unable to explain the complex relationships between the various disciplines concerned with sustainable development, and cannot help so much to design pragmatic responses.

Instead of paradigms, we prefer another epistemological concept, developed recently by Laudan: *research traditions*. According to Laudan (7), the concept of research tradition is more capable of coping with the diversity and complexity of current scientific practices than the concept of paradigm, which was tailored to explain the history of natural sciences. A research tradition is a set of particular theories, which together contribute to solve both conceptual and empirical problems in a research area. While a paradigm is either new and accepted or old and rejected, a research tradition is more or less alive or dying, fertile or sterile. It is healthy as long as it is appropriate to solve the problems it is confronted with. Research traditions distinguish themselves by their methods, their prescriptions, their general assumptions, their representations of the world and their ethical background. Different research traditions may exist at the same time, as well as different schools within a research tradition.

---

(5) Renn O., Kastenholz H.G., op. cit. pp. 89-91. Renn O., op. cit. pp. 8-10.

(6) Faucheux S., Noël J-F., *Economie des ressources naturelles et de l'environnement*, Ed. Armand Colin, Paris, 1995, pp. 17-61.

(7) Laudan L., *La dynamique de la science*, Editions Mardaga, Bruxelles, 1987, pp. 92-124.
Laudan L., *Progress and its problems: towards a theory of scientific growth*, Routledge & Kegan Publishers, London, 1977.

This diversity reflects pluralism in science and is considered as a key positive factor in the dynamics of science.

These are the main reasons why we use the concept of research tradition in order to develop our interpretation of the conceptual diversity of « sustainability ».

2. Research Traditions, Relationships between Disciplines and Pathways for Technological Innovation

Based on the various explanatory factors described above, we distinguish four evolving research traditions, regarding the practice of science and the options for technological innovation and industrial development.

2.1. The « Ecosystemic » Research Tradition

The issue of sustainable development can be summarised as follows. Our planet is confronted with a lot of new ecological challenges and increasing threats, that require a deep conversion of scientists. No current models of development can survive because of the « objective limits » of the carrying capacity of the Earth. The various schools and variants within this research tradition mainly differ from the degree of importance given to the social aspects (distribution of wealth, solidarity and justice) and to social sciences. Anyway, sustainable development must be the new model, capable of guaranteeing this carrying capacity in the long term. Science and technology must help to provide us with new knowledge and new solutions.

In this research tradition, the weight of natural sciences is very important. They have a key role to play in their relationships with other disciplines. Natural sciences have to give the correct explanations about the « objective limits » and to define a framework for working out solutions. Other disciplines, such as economics, social sciences, law, engineering, are considered as instruments that can help to implement the solutions indicated by natural sciences. For instance, a lot of natural scientists adopt this behaviour in relation to climate change and greenhouse effect.

The challenge for industrial development is to cope with those « objective limits », which are objective constraints. Ecological goals and environmental standards (emissions, energy consumption, waste production) have to be as severe as possible and industry has to find the most cost-effective ways to adapt itself to the new constraints, should it be achieved by end-of-pipe technology or cleaner technology.

Interdisciplinarity is required in this research tradition, but the relationships between disciplines are polarised around natural sciences. Other sciences and technologies are considered as instruments to be used in the general framework defined by natural sciences. Interdisciplinarity may be reduced to a kind of « general scientific culture » that has to be shared by all scientific disciplines.

2.2. The Research Tradition of « Development Economics »

The concept of sustainable development is mainly perceived as a challenge for the theories of growth and regulation and their application as macro-economic tools and models. A key divergence with the « ecosystemic » research tradition is that the present one rejects the existence of *objective and absolute limits* given by natural sciences, because this approach is too « malthusian ». Global environmental challenges are rather considered as *evolving and relative constraints*, which can be modified with a new organisation of economy and appropriate technological innovation. In relation to the former economic theories, the newness consists of the structural and long-term character of ecological constraints and of the need for integration of ecological variables into economic theories and instruments.

There are, of course, a lot of schools within this research tradition. A distinction can be made between those who try to integrate environmental challenges into neo-classical theories and instruments, and those who are convinced that current models are no longer valid at all and that there is an urgent need for new theories. The concept of *qualitative growth* belongs to the latter. Qualitative growth should be based on an increasing productivity of natural resources (high output for low input), on a careful management of the substitution between natural and artificial capital, taking into account the regeneration capacities, and on a new ethics of relationships between nature and society.

Insofar as industrial development has to deal with evolving constraints and not with objective limits, regulation becomes a central instrument. Industry has to turn into a process of « ecological modernisation », as explained in section 3. The priorities for technological innovations are determined by growth models. These models are not the same in all the regions of the world. «Regional sustainable development » is therefore a relevant issue.

This research tradition also requires new interdisciplinary practices. Economics (in a general meaning) plays a central part in these practices and has the main explanatory function. Social sciences have a less central explanatory function, as far as they are concerned with the contextual factors of the economic interpretations. Natural sciences have to enlighten the environmental constraints and to update the required knowledge. Technology, political and juridical sciences, health sciences have to design instruments and practical solutions. The general relationships between economics and other sciences can be characterised by the fact that the latter are expected to give decision-making methods and implementation tools.

2.3. The Research Tradition of « Environmental Innovation »

This research tradition is based on the innovative potential of science and technology in order to move back the boundaries and constraints due to entropy (universal trend to degradation of energy and materials). Technological innovation has to concern itself with efficiency, reliability and resources saving.

Sustainable development is conceived as a problem-oriented approach, with more emphasis on pragmatic initiatives than on global dimensions. The main operational principles are: completing life cycles in order to reduce emissions and waste, optimising product and process life cycles, chaining life cycles so that the output of one can become the input of another, improving yields and productivity of energy and material resources, etc. Specific methods are developed: life cycle assessment, ecological balances, material flow charts, etc. Different variants within this research tradition are related to the level of problems (micro or macro level) and to the underlying organisation of society: balances between regulation and competition, individualism and solidarity, incentive and coercive policies.

As regards industrial development, this research tradition introduces new operational concepts, which are not really taken into account in the other research traditions: technology transfer, life cycle assessment, product chain analysis, risk assessment. An emphasis is put on environmental management, rather than on economic policy and regulation.

Interdisciplinarity is organised on a pragmatic basis: the problem to solve determines which disciplines are required. Applied sciences, engineering, management sciences and industrial economics play however a rather central part. Natural sciences are considered as a provider of basic knowledge, while social sciences are considered as a tool for improving the conditions of diffusion of technological innovations.

2.4. The « Constructivist » Research Tradition

As all scientific concepts, the concept of sustainable development is socially constructed. Its purpose is to make human intervention upon the biosphere more compatible with culture and society, taking into account that the various social groups have build up their own images of environment and society. The key issue is not the objective assessment of ecological limits and global changes, but the perception of these changes as challenges for welfare today and tomorrow. Solutions are not given by science, but worked out within society, and science is only a tool among others. Sustainable development is a matter for public debate.

This research tradition introduces new focus in the approaches to sustainable development:

- Institutions and social actors play an important part in the construction of sustainable development, as far as they represent convergent and divergent interests within society.
- Consensus and controversies are a driving force in the construction process of the concept. They are developed through public debate and enhanced communication between research and society.
- The implementation of sustainable development is a matter for negotiation and policy-making. Bottom-up processes are preferable to top-down measures. The term « negotiated environment » is quite typical of this approach.

Industrial development and technological innovation are also considered as constructed processes, through participation, consultation and debate. They are policies and not mechanisms. They have to be assessed by society, not only by scientists and decision makers. For instance, cleaner technology and green products cannot be defined only by engineers and managers. They have also to take into account the interests of workers, consumers and groups of citizens. Furthermore, the diffusion process of cleaner technology is more critical than innovation itself.

Interdisciplinarity is a strong requirement. The relationships between scientific disciplines have to be studied in a constructivist perspective, it means through an analysis of actors and controversies within the scientific community. Although no central role is given to any scientific discipline, the basic principles of the sociology of sciences are often supposed to underlie this research tradition. The experiences and methods of Technology Assessment, particularly those which are based on public participation and public debate, are a source of inspiration for implementing interdisciplinarity.

2.5. The Usefulness of the Concept of Research Tradition

In conclusion of this section, we can point out some main advantages of the concept of research tradition:

- this concept provides us with a better explanation of conceptual diversity and pluralism than the common use of « paradigms »;
- it gives an interpretation of the ways industrial development is considered in each research tradition;
- it also proposes different models for the relationships between scientific disciplines, and therefore for interdisciplinarity itself.

This concept is, however, strongly based on epistemology. It is very fruitful to discuss interdisciplinarity among sciences, but less fruitful to enlighten the question of interdisciplinarity in the implementation of innovation processes. It is the subject of the next section.

3. Characteristics of « Sustainable Technology »

The term « sustainable technology » has to be used carefully. It differs from environmental technology. Both are problem-oriented, but environmental technology pays little attention to the social and economic aspects, while sustainable technology has to integrate the three basic components of sustainable development, such as described in section 1. Moreover, sustainable technology has to be understood in the more general framework of innovation policies.

3.1 The Need for a Socio-Economic Perspective

All research traditions recognise that technological innovation must contribute to the development of a new model of growth and regulation of the economy and that it plays a key role in transforming the present production system into something more sustainable.

However, it is quite important that the analysis of sustainable technology should be extended beyond technological innovation in the strictest sense. It must take into account the socio-economic changes associated with such innovations. Changes in competitiveness and employment are two key questions raised by the prospect of « ecological modernisation ». Research in this area has to cover both topics.

By and large, the added value of sustainable technology, in comparison with environmental technology, is to consider the short-term situation from a long-term perspective. It has also to take into account the relations between North and South (technology transfer, distribution of welfare). Such an approach presents a lot of positive points:

- It enables a clearer identification of the links between sustainable technological innovation and the structural changes needed by sustainable development in the different branches of industry.
- It gives a broader perspective of certain crucial questions about employment, such as the evolution of the productivity of sustainable technologies and the relative significance of direct effects, indirect effects and induced effects on employment.
- Finally, it clarifies the relationship between the dynamics of technological innovation and the concept of qualitative growth. This concept is slightly different from pure economic theories. It gives a more important place to technological innovation and social aspects.

Finally, it is impossible to take up the challenge of sustainable technology without taking into account the relationships between technological innovation and the other instruments fostering sustainable development, such as environmental regulation, economic instruments (eco-taxes, charges, subventions, etc.), public procurement policies, social and institutional conditions increasing the acceptability of changes.

3.2 A problem-oriented approach

However different, sustainable technology and environmental technology are obviously linked to each other. An overview of what can be labelled « environmental technology » shows plenty of techniques, projects and small implementations of any kind, which are often designed as short-term operational solutions. Environmental technology appears to be mainly problem-driven. In order to put some structure in this wide spectrum, we can distinguish six types of technologies, related to six categories of purposes.

1. *Managing the final stage of life cycles: end-of-pipe technologies*
   Plenty of environmental technologies are designed to process pollution downstream from industrial production and home activities: waste or water processing, decontamination, emission filtering, etc. These technologies are mainly based on well known physical and chemical principles and derived from applied research.

2. *Regenerating the ecosystems: restoring technologies*
   Other technologies are devoted to restoring the quality of ecosystems threatened by erosion, desertification, acidification, eutrophisation and other ecological challenges. They need a deeper understanding of the ecological problems than classical end-of-pipe technologies.

3. *Monitoring the environmental quality: observation methods and tools*
   These technologies are based on instrumentation, measurement devices, satellite detection, data and image processing, telematic networks.

4. *Reducing risks: prevention technologies*
   The prevention of technological risks is a major challenge for innovation. In some cases, prevention can be achieved by adding safety techniques to the existing industrial processes. In many cases however, prevention needs a deep transformation of the production process itself, including new interfaces between man and machine and organisational innovations at the work place.

5. *Preventing resources exhaustion: lean technologies*
   Technology can play an important part in preventing the depletion of non renewable energy sources and raw materials. The rational use of energy is however an old purpose for which little progress has been really achieved, despite a lot of technical improvements and inventions. The political, social and economic process of diffusion of innovations is therefore a key issue.

6. *Changing the technological basis of industry: clean technologies*
   In order to deal with the long-term environmental challenges, technology needs to be *built in* rather than *add on* the production infrastructure. Such structural changes can consist of process innovations, product innovations or organisational innovations.

However, this problem-oriented character will only become a pathway for sustainable development if it is combined with a socio-economic perspective. This is not always so. If we go back to the first section of this paper and remember the three components of sustainable development (the question of ecology, the question of solidarity and justice and the question of economic growth and regulation), we can see that the problem-oriented character of the environmental technologies often addresses only one single component of sustainable development.

3.3 From environmental technology to sustainable technology

Another distinction, proposed in a recent study of the Office of Technology Assessment of the German Parliament (TAB) (8), is useful for our discussion. This is the distinction between *add-on technology* and *integrated technology*. This distinction appears as a transversal characteristics of the six categories described above.

- Add-on technology often consists of short term solutions implemented in order to encounter specific regulation. The place for socio-economic concern is very small. These solutions seem easier to implement because they do not need a deep modification of the production process.

- Integrated technology is designed as a long-term solution. It requires higher investment and conversion costs, but may generate better competitiveness and lower costs in the long term. It can give the opportunity to integrate social and economic concerns.

It results from this short overview that integrated technology is the best technological way for sustainable development. Nevertheless it would be a mistake to underestimate the role played by add-on technology in the fight against environmental pollution. However, the concept of « sustainable technology » requires that the design of technological solutions take into account the socio-economic aspects and not only the ecological aspects. It means that research in this area has to integrate the three basic components of the concept of sustainable development, even if it is with different priorities.

The requirement for interdisciplinarity is of course much higher for sustainable technology than for environmental technology. Add-on techniques are often developed within a single discipline, while integrated technology needs an interaction between the different approaches of natural and social sciences.

4. Questions for Research and Interdisciplinarity

4.1 Characteristics of Research dealing with Sustainable Technology

In a previous report (9), we had pointed out that the various types of research dealing with sustainable development could be split into two categories:

- Research *about* sustainable development, such as for example: research dealing with the role of science in society or the relation between man and nature, research on the concept of sustainable development, on implementation problems, on the assessment of environmental policies, on specific tools and methods such as statistical indicators or life cycle assessment.

---

(8) Coenen R., Klein-Vielhauer S., Meyer R., *Umwelttechnik und wirtschaftliche Entwicklung*, Büro für Technikfolgen Abschätzung (TAB), Bundestag, Bonn, 1996.

(9) Valenduc & al., Berloznik & al., op. cit., pp. 97-102.

- Research *in support of* sustainable development. This means all research which studies the practical problems linked with sustainable development (climate, environment, life style, etc.). This research is often done within existing disciplines, with existing methods and approaches. It does not refer to new disciplines but it is mainly characterised by shifts in different existing disciplines.

Up to now, research in the area of sustainable technology mainly belongs to this second category. There is however a need for research belonging to the first category, as for instance research on the diffusion processes of innovations, on the impacts on employment and quality of work, on technology assessment.

We can also identify several *transversal dimensions* of research dealing with sustainable development. We can distinguish two groups, the first one dealing with the content of research and the second one dealing with the form in which research is carried out.

- As regards the *content* we observe that research dealing with sustainable development is characterised by a strong *intergenerational dimension*. It is one of the core ideas of sustainable development. The same holds for the *global / local dimension*. Sustainable development research tries to link directly or indirectly local issues with global issues, and vice versa.

- As regards the *form*, the first aspect is the *multidisciplinary dimension*. It responds to the need to produce integrated knowledge and to establish a clear link between problems and solutions. Another dimension is the *societal dimension*. This has to do with the communication of science, but also with the fact that science for sustainable development is closely linked to societal objectives. Thus, there has to be a clear engagement on the part of the researcher and the funding institution in terms of sustainable development objectives. Societal engagement is closely linked to the relationship between science and sustainable development.

4.2 About Interdisciplinarity

In conclusion we would like to summarise some topics related to interdisciplinarity, which were mentioned in the previous sections of our paper.

1. The different research traditions do not require the same level of interdisciplinarity. At least two levels can be distinguished:

    - level 1: a common scientific culture about sustainable development, made up with elements from various disciplines in natural and social sciences;
    - level 2: common research projects, designed by scientists from different disciplines, in order to deal with a problem that requires an interdisciplinary approach.

2. There are different patterns of relationships between scientific disciplines. Each research tradition develops its own pattern, in which there are often core disciplines and peripheral disciplines.

3. Research on sustainable technology requires an interdisciplinary approach rather than a disciplinary perspective, because of the problem-oriented character and of the socio-economic aspects that cannot be ignored.

4. However, the need for interdisciplinarity is variable along the successive steps of the innovation process. The forms of interdisciplinarity are not the same at the design stage, at the experimental stage or during the diffusion process.

5. Interdisciplinarity does not only mean dialogue between scientific disciplines, but also communication between research and society. A better scientific communication is necessary in order to improve the involvement of concerned groups within society.