Common technology development concepts - their limits and options of success for sustainable development

Why sustainable technology development needs fundamentally new strategies in process-design, management and policy

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Abstract

In general the concepts for developing new technologies that emphasizes to contribute to a more sustainable future have great options but also limits. Such limits can be seen as disadvantages just as well as important challenge to overcome. Grouped in two categories we distinguish limits or barriers owing from the societal, political and economic systems and limits that arise inherent from the technology development concept itself. Formulated in six theses the structural limits derived form the system are: resource efficiency requires cost verity; the rebound-effect overcompensates all economizing effects; velocity of innovation kills the possibility for feed-back and learning; sustainable development requires also a change of individual life-style; institutional obstacles act as impediments for optimizing the system; regions and local initiatives are the basis for sustainability. These theses are corresponding to the first six chapters of the contribution.

The main lacks and mistakes based in the development concepts for new technologies themselves are: problem-oriented strategies that try to optimise, improve or re-design a special product or technology, which only leads to smaller "cosmetic corrections" instead of vision-oriented strategies that focus on the fundamental renewal of our systems e.g. through paradigm shift, transdisciplinarity, networking; symptom-based instead of causal-based concepts; repairing instead of precautionary principles; product- and technology-oriented instead of system-oriented strategies; focus on technical restrictions instead of clarifying restrictions of awareness; today stagnation and "stagnovation" processes are common instead of the will for real innovations for a sustainable development; conserving structures instead of learning and evolving concepts including reflection and feed-back; and last not least a great lack of knowledge, wisdom or even courage in transforming ecological and ethical principles into politics and technosphere.

As a consequence of this analysis and a positive contribution to a further advancement I suggest a development concept with a six steps architecture, that could lead to a fundamental new process for evolving sustainable technologies: 1) Positioning - based on ecological and ethical principles, 2) Reversing - turning the classical concepts around, 3) Visioning - long-term guiding visions and future orientation, 4) Backcasting - objectives and actions starting with the end in mind, 5) Reflection - integration of feed-back loops and learning methods like self-evaluation and 6) Networking - operational participation structures and synergetic co-evolutionary processes. This proposal tries to stimulate the dialogue in creating a new vision that might have the power to shift and turn around our unsustainable technological systems. Herby also national and EU politics - their duties and responsibilities are described in the last chapter - are directly addressed and called to establish possibilities for real systems renewal.

Contents

"Never doubt that a small group of thoughtful,
committed citizens can change the world.
Indeed, it is the only thing that ever has."

Margaret Mead, Anthropologist (1901-1978)

1 Resource efficiency requires cost verity

Factor 4, Factor 10 or eco-efficiency are all key terms in the process of developing and measuring sustainability. To be sustainable during a period when human populations are likely to double and average living standards increase significantly, and since it's given that western societies typically consume 20 to 30 times more than their less developed counterparts, industry needs to increase its resource conversion efficiency by a minimum Factor 4 to 10 (90% reductions). Factor 4 and other technology-oriented concepts are therefore considered as tools for measuring these reductions. But these concepts have strong limits.

If the strategy of "Factor 4 and beyond" is used in processes for innovating and renewing products and services it has to lead into more efficient use of resources. Eco-efficiency - by definition - involves the provision 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 absorbing and carrying capacity. Thus every strategy to increase resource and eco-efficiency can only be sustainable, if the underlying system (i.e. transport system) itself is questioned in the first place. Then a fundamental course has to be set up and followed in the direction of sustainable development. True costs of products and services hereby are one of the major requirements and necessities in initiating this change.

2 Rebound-effect overcompensates all economizing effects

Examining the history of technology, we realise that the common paths of development are definitely not sustainable at all. While there has always been the hope of handling imminent problems by applying powerful new technical solutions, this route has only been successful in the short term. In the long term, it has almost invariably led to a change for the worse of the situation. It is perhaps an inevitable consequence of world market conditions, and maybe also of human nature, that technological progress is generally "abused." The accompanying potential for dematerialization always ends up in a growing world population and in the generation of always more products, more services, more energy use and so forth. This common development-scheme leads to such an extent of resource use that it massively overcompensates for the original technological progress made, and essentially eliminates the potential overall reduction. This trend, referred to as the "rebound effect", turns out to be a dominant feature of the present economic system.

Within a modified economic system, it may be possible, by way of increasing the efficiency of technologies and processes and by learning to work together more interdisciplinarily, to lower the material content of products and economic activities - a process which is known as dematerialization. However, such technology-based options will have to be implemented carefully and always in consideration of the rebound effects. This means, that the subsequent erosion of the positive potential of technological innovation by increases in overall activities, and the concomitant increase in consumption of material and energy have to be avoided through a change in values, behaviour and habits. Although one main result of flooding the world with consumer goods, which was diagnosed by Victor Papanek, it is deep human dissatisfaction.

3 Velocity of innovation kills the possibility for feed-back and learning

Nowadays innovations are introduced into the market in shorter and shorter intervals. Consequently the time span from the initial idea to the concrete realisation and launch of the product has been dramatically reduced in these times. Permanent introduction of new products does not encourage the consumer to give feed-back on quality and benefits in order to improve the generation-before product.

In a sense, technological progress has been the very means by which natural resources have been transformed with increasing rapidity into goods, services and functions. Dema-

terialization has, unfortunately, been one of the primary inputs into this acceleration process. Never have humans been so successful and so prepared to change and modify their world by technology, and we never have created more waste and flows of material - faster and faster - than today. In part this also results from the fact that up to now saving labour is a much more effective strategy to survive in the market than saving resources.
Charlie Chaplin said in the film “The Great Dictator” (1942): "We have developed speed, but we have shut ourselves in. Machinery that gives abundance has left us in want."

4 Sustainable development requires a change of individual lifestyles

Since 1980, it is true, the gross national product has increased in the rich Northern countries whereas the Index for Sustainable Economic Welfare (ISEW) has remained the same. GNP only increases in regard of expenses for repairs of secondary damages which now becomes necessary due to our presently non-sustainable economic system. Sustainable development has to put emphasis on increase of social welfare and requires a reconstruction of fields of life such as accommodation, nutrition, work, consumption, leisure time, education and mobility, all in consideration of a high living standard: „Living good instead of having a lot!“, so to speak.

To safeguard the future is, more than anything, a question of our values and ethical principles: what do we consider good or bad, what do we desire or reject, what are we prepared to support or to fight for. Sustainable development has - without doubt - to go along with a shift in values and behaviour of mankind. Over time, human and social values have to change. Concepts that once seemed extraordinary (e.g. emancipating slaves, enfranchising women) are now taken for granted. New concepts like responsible consumerism, environmental justice, intra- and inter-generational equity are now coming up the curve.

If we are to overcome today's situation, we will require a clear ethical orientation and, on the basis of long-term criteria, good judgement as to the positive or negative effects and consequences of human behaviour and action. The main question is still: How can we reverse the current dangerous global trends of population growth, over-consumption of resources, poverty and quality of life and imminent global catastrophes?

5 Institutional obstacles act as a great impediment for optimizing the system

From the time on when institutional departments like administration, political divisions, universities, research institutions etc. were subdivided into sections we have learned that we tend to look only for partial solutions instead of an optimal solution for the whole system (efficiency by synergy). But sustainable development is more a communicative than a technical process, i.e. progress can only occur when presently separated areas come to work hand in hand.

The achievement of global sustainability will require this new and much more holistic approach. Within the development of a new "global" framework, the world economic and political systems has to be modified to incorporate social, regional and ecological considerations in a globally adequate manner.

Real improvements in eco-efficiency requires holistic, intensive and ambitious efforts to achieve a fundamental change in culture, structure (institutional, political, systemic) and technology. Eco-efficiency therefore can be interpreted as a mixture of three important eco-principles:

- o sufficiency in fulfilling all social and cultural needs, that have to be legitimated by politics, bureaucracy and jurisdiction in their nature and extent
- o effectiveness in the institutional and structural organisation of fulfilling these legitimated needs and
- o efficiency in the "translation" of this needs by means and tools of technology.

In Fig. 1 the concept of eco-efficiency (separated in the three important principles sufficiency, effectiveness and efficiency) is illustrated as a function of materials and energy flow that are needed to cover the needs and wants of our society.

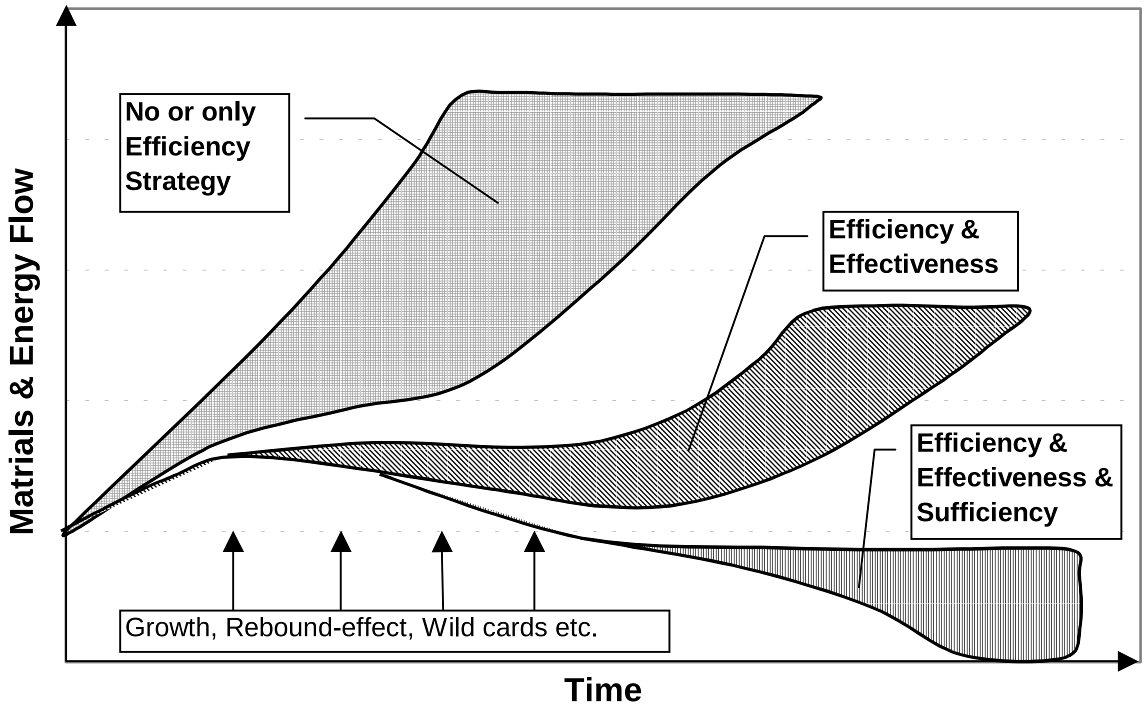

Fig. 1: Combination of the three eco-principles efficiency, effectiveness and sufficiency and their effect on materials & energy flow in a stretch of time of approximately 50 years.

6 Regions and local initiatives are the basis for sustainability

Resource efficiency is one of the crucial targets on a global scale. But sustainable development needs to be established on a regional level. Hereby also the following targets are of global necessity: use of renewable resources, service orientation, risk precaution, job preserving and many more. As said before, the establishment of appropriate global frameworks for sustainability needs to combine local contributions and activities to sustainability on the regional scale.

Only local projects and initiatives can make contributions toward sustainable development by making individuals aware of global problems and acting as a model for further activities. However, local projects can have counterproductive effects in the global total. This can be the case, for instance, if they merely cause ecological and social burdens to be exported to other localities instead of avoiding the burdens altogether. Therefore, determining whether a local initiative is good is often a question of weighing the good against the bad.

A main factor to avoid unsustainable results on the local scale is the orientation to a guiding vision which has to be developed by reflecting the common and world-wide principles of sustainability. Hence bottom-up processes are important counterbalances to top-down approaches deriving from national or super-national authorities. By realizing that there is no way around the regions to initiate a course of change, the single states have to create appropriate conditions for setting off local initiatives that will forward the cause of sustainable development. Summing it up in the words of J. F. Kennedy: "All politics is local!"

7 Sustainable technology development needs new strategies in process-design

As a short overview the main (hidden) gaps or mistakes in the common technology-development for increasing sustainability are listed below. The overview can be seen as an analysis through the main common technology development concepts, as Factor 4, 4+, 10 and beyond, MIPS - concept, industrial ecology, cleaner production and clean technologies, zero emission and upcycling, life cycle assessment and design, integrated-, eco- and sustainable product design, environmental management systems, eco-efficiency etc.. In the same list also possible solutions and strategies, that might shape technology development to a more sustainable future are put opposite:

- problem-oriented strategies that try to optimise, improve or re-design a special product or technology, which only leads to smaller "corrections" instead of vision-oriented strategies that focus on the renewal of our systems e.g. through paradigm shift and transdisciplinarity
- symptom-based instead of causal-based concepts
- repairing instead of precautionary principles
- product- and technology-oriented instead of system-oriented strategies
- focus on technical restrictions instead of restrictions of awareness

- o stagnation and "stagnovation" processes instead of real innovations for a sustainable development
- o conserving instead of learning and evolving concepts (including reflection and feed-back)
- o lack of transformation of ecological principles into technology guidelines like viability, interaction, self-organisation, subsidiarity, co-evolution, principle of learning and development etc.

This summary of applicable criteria can help to lead us to a more sustainable design of new technologies (eco-technologies). A set of main eco-principles should act as useful but compulsory guidelines to reach the goal of a drastic minimization of resource exploitation and wastage. Such eco-principles or guidelines for redesigning industry which can be derived direct from system analyses and bio-cybernetics of nature are for example:

- o sufficiency / effectiveness / efficiency (eco-efficiency)
- o embeddedness / non-Invasiveness
- o flexibility and ability of adaptation
- o ability of learning, reflection and (also negative) feed-back loops
- o process ability and ability of evolutionary development
- o mixed and multi functionality
- o minimizing risk / toxicity / susceptibility to failure
- o life-cycle orientation / need orientation
- o paradigm shift and behaviour oriented
- o creativity, beauty, attractiveness and ability to change life-styles.

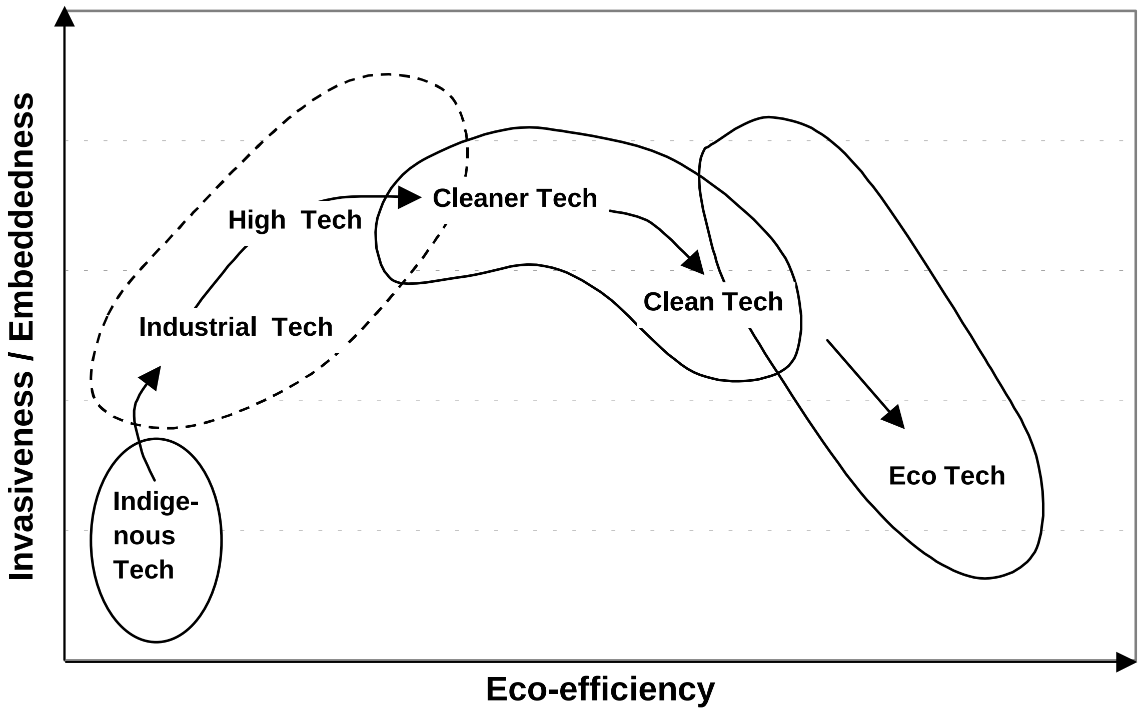

Fig. 2: Invasiveness versus eco-efficiency as observed in different technologies (according to life-styles) and a principle way for developing a sustainable eco-technology (on the basis of Moser, 1997)

This list is beyond doubt incomplete, but the usefulness of such a set of derived eco-principles can be demonstrated as shown in fig. 2. Two groups of such principles namely invasiveness/embeddedness and eco-efficiency are used to analyse different technology paradigms. As a result eco-technologies (and of course corresponding eco-life-styles) are predicted to be as non-invasive as ancient indigenous technologies (life-styles) but with a several times higher eco-efficiency based on intelligent and system-oriented eco-engineering work.

8 Optimisation - improvement - renewal: which strategy will bring us a sustainable future - none, one or all?

In many higher industrialized states and in different sectors of the economy, clear and impressive results on environment protection and conservation or on prevention of future damage have been achieved. Three main dimensions or directions of change "trajectories" can be distinguished: optimisation, improvement and renewal. But they should not be separated, since in the process of sustainable development “optimisation” and “improvement” with respect to resources and environment have been developed and implemented in the last decades. National and European policy programs and industrial initiatives helped gathering the “low hanging fruits”. But nevertheless hardly any breakthrough was made to the important renewal of our systems for establishing real options for a sustainable development.

One severe barrier might be the general complexity of the political, economic and social processes which are necessary to initiate such breakthroughs. To open sustainable future options development and innovation processes have to be initiated on the basis of a clear understanding of the challenges and acceptance of crucial ethical, social and ecological values behind the process. In that case we have to find answers on the most urgent questions: Which actions and policies of transition in public and private have to be undertaken to achieve a sustainable future by and fundamental renewal of our technology system? This question leads directly to the strong need for transformation - knowledge.[1] (Forum für Klima und Global Change, 1998). And further: which strategies, concepts and processes, could break through the persistent refusal of change in an evolutionary way to initiate a broad supported movement which achieve real sustainable actions and policies? By whom and how could this happen? And finally when will the combination of urgency of development and the time necessary for fundamental change induce the urgency of action?

To answer such a convolute of questions we have to become aware of the "nature", the character of the challenge. In the Brundtland report (WCED, 1987) sustainable development is described as “fulfilling peoples needs of the present and future generations” ac-

[1] In knowledge management three different types of knowledge are distinguished: 1) system knowledge - "knowing what is", 2) target knowledge - "knowing what should be and what shouldn't be" and 3) transformation knowledge - "knowing how to come from the actual state (what is) to a common desired future state (what should be)".

cording to the requires actions on short, medium and long term. “Future generations” may be supposed to be three or four generations and this covers a period of about 50 to 70 years. Considering the almost unavoidable growth of the world population, the desired growth of welfare per capita in North and South (RIO 21) and the desired (or “necessary”) reduction of environmental pressure from local up to global scales, sustainable development and the fulfilling of peoples needs requires radical improvement of the eco-efficiency. The factors therefore ranges from 5 to 50, depending on assumptions, specific need and life-style. But such requirement demands for fundamental renewal of all systems (especially technology) to provide these needs. Form history we know, that a fundamental system renewal takes several decades - a wording says three generations. Considering the growing velocity in every processes this period might be shorter, but nevertheless it's about high time to bring sustainable technology development form concept to market.

We live in an economy oriented and dominated time period. Such drastic improvements in the eco-efficiency of our processes and technologies have to fit in the time scope that business is accustomed to usual decision making and action planning. This reflects leads to in a threefold approach along parallel guiding lines (trajectories):

1. System Optimisation, corresponding to operational processes like quality management, maintenance, auditing, efficiency drives etc., all with time scales up to 5 years maximum and with an expected effect on eco-efficiency ranging up to a factor 2 ½.
2. System Improvement, leaving fundamental structures and technologies unchanged but implementing incremental changes corresponding to processes like revision, reorganisation, redesign with time scales from 5 to 20 years and with an expected effect on eco-efficiency ranging from a factor 2 ½ up to 5.
3. System Renewal, by fundamental jump-like changes, resulting from long term research and affecting structure, culture and technology fundamentally, with time scales of over 25 years and possible efficiency factors from 20 and more (see fig. 3; Jansen, 2000).

9 Only systems renewal can lead us to factors 10 and beyond

System renewal of technology means a fundamentally redefining of the actual technology development trajectories. Renewal has to initiate and provoce new processes aiming to increase eco-efficiency by factors between 5 and 50, whereby factors 10 to 20 could serve as midterm targets at least for developed countries. If we compare a real system renewal with system optimisation and system improvement, the renewal process is characterised by:

- a long time scale of about 25 to 50 years,
- a high rate of uncertainties with high complexity,
- involvement of many actors
- in a transdisciplinarial dialugue form and with
- strong interaction between the dimensions ecology, economy and society.

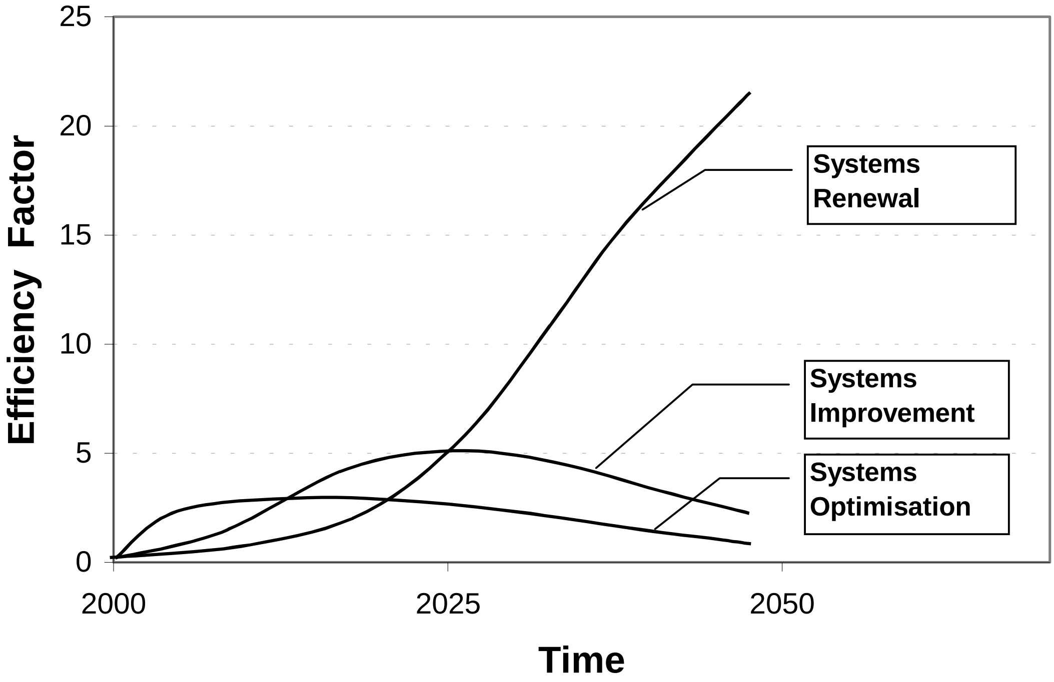

Fig. 3: Different guiding lines - trajectories of change (systems optimisation, improvement and renewal) and their impact on efficiency factors in time (on the basis of Jansen, 2000)

Since the strategies of optimisation and improvement are more or less covered by actual policies and policy instruments e.g. through special programs in the member states of the EU, the real challenge is the ambitious initiation and implementation of processes for a real systems renewal. The future generations-concept described before implies the necessity of such a renewal within the next decades. And as explained at the same time fundamental system renewal takes several years of time from concept to market. These terms of time go far beyond the periods which are usual in business.

To cope with the main challenges and dilemmas of today's world, the process of systems renewal has to have a special characteristic:

- handling uncertainties on long term trends and risks, including different risk perceptions based on different appreciation of normative and scientific analyses and future expectations,
- new roles and forms of co-operation between market, science & technology and government and NGO's taking their specific strengths, weaknesses and responsibilities into account,
- involvement and participation of many actors, stake holders and partners,
- bridging between the drive of competition and the necessity of co-operation,
- arrangements that often are crossing economic and sectoral borders,
- the three dimensions of sustainability - nature, economy and society - are considered not only from a principal point of view but also from the practical interest of viability of new means, products and processes.

All points mentioned above requires transparency and new forms of participation in design, architecture and management of the process for a sustainable technology development. It's lying in the things, that to break through to a new era of sustainable Eco-Technologies we have to try new ways. Since: "If you always do what you always did - you will always get what you always got (Benjamin Franklin)."

10 Main tasks for technology development in process design, architecture and management

On the basis of the analysis of the systemic limits and barriers towards a sustainable development and the inherent obstacles which are laying in the development process of new technologies itself, a proposal for a step-wise process to break through the inertia in an evolutionary way is given below. Since we have more or less the knowledge of the main guiding principles for a sustainable development, a fundamentally new process for technology development has to be elaborated. As a preliminary scheme I suggest a model shown in table 1 with six steps, that could lead us to this new process for sustainable technology development:

Tabel 1: Six step concept for a "Sustainable Technology Development - Process"

Step 1:	**Positioning**	transformation of ecological and ethical principles into techno- and socio-sphere
Step 2:	**Reversing**	turning the classical concepts around and open them systemically (bottom up)
Step 3:	**Visioning**	creating long-term guiding visions, future orientations and scenarios with the help of vision assessment
Step 4:	**Backcasting**	elaborating objectives, mid term targets, mile stones and actions through the backcasting method
Step 5:	**Reflection**	integration of feed-back methods to establish learning and developing structures (self-evaluation etc.)
Step 6:	**Networking**	synthesising all steps through operational dialogue and participation forms and using synergetic co-evolutionary processes (LA 21 etc.)

This scheme might help us to create a fundamentally new technology development process, which - of course - has to be implemented and improved in real demonstration projects. To let this vision become true, political programmes for sustainable technology development in special fields like housing, mobility, consuming and nutrition have to be established regionally, nationally and globally. This proposal is made to stimulate processes that might have the power to shift or turn around our unsustainable systems.

11 Visioning and backcasting as the heart of the new technology development process

In systems renewal broadly shared future orientations serve primarily as a source for a backcasting procedure to design innovation paths for development of sustainable technologies or policy programs. Outgoing from a common developed guiding vision these orientation may as well help to focus ongoing system optimisation and system improvement or redesign. Fig. 4. is giving a brief overview about the general positive functions of a guiding vision.

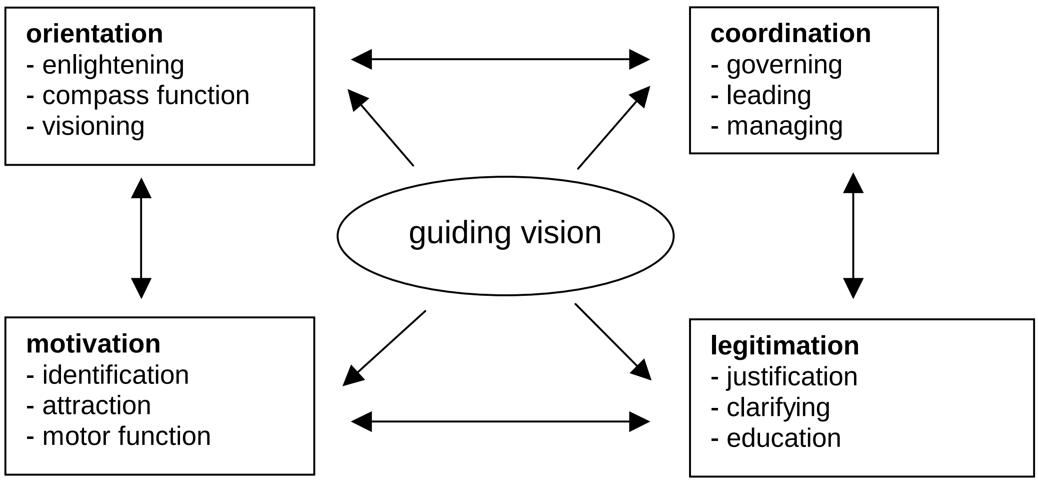

Fig. 4: Functions of guiding visions (future orientation)

Some barriers for real systems renewal are obvious: A heavily co-ordinated top down procedure may well result in a killing bureaucratic system. The expression "future orientation**"** or "guiding vision" rather than "view" or "picture" not to say "blue print" is meant to indicate that the orientation should be a rough one giving room for specific interpretations and flexible adaptation. Like the WCED report "Our Common Future" (1987) gives an orientation on development. Another illustrative orientation is the common goal in the post (2nd World) War period in Western Europe: Rebuild and Reconstruct Europe. Future orientations may well be developed top-down as well as bottom-up.

A bottom-up developed guiding vision delivers indications on the desired terms of reference for higher levels. But its disadvantage is the lack of insight in the effects of neighbouring, national and global orientations. Top-down indicates the systems borders and may be essential to overview dominant robust trends in society, economy and governance. A conclusion can be made as following: Top-down and bottom-up approaches are both necessary, act complimentary and may be applied without heavy formal co-ordination. Communication, dialogue and consensus between relevant parties however is essential. The different levels of exploration may be regarded as a sequence of divergent and convergent processes, but all of them are urgent for sustaining our society.

12 The role of policy in technology development on national and EU level

Experiences on national scale. If we look at the national scale, many experiences have been obtained in general foresight programs for economic development. Their time scales were up to about 15 years. As a main goal of these programs we learned how to organise dialogue and co-operation between different parties (private, public, science …). But the degree of taking sustainable development into account quite differs from one to the other national effort. However different experience e.g. in the Dutch STD Programme (Sustainable Technology Development; Weaver et al., 2000 and Bundestag, 1998) showed clearly, that to achieve a fundamental renewal the time scale has to be stretched form some years up to some decades. These Dutch experiences demonstrates, that innovation processes are opening options for radical renewal of technology systems on the long term, fitting in the process of sustainable development can be initiated, organized and handled. Systems Innovation has been thoroughly investigated and practised also in the Netherlands by the Dutch National Council on Agricultural Research (Rutten et al., 2000). They are clearly illustrating the possibility to develop shared visions and ambitions. It should be noticed however that although these Dutch experiences were inspired by Rio 1992, Agenda 21 and different national policies like the NEPP's (National Environmental Policy Plans), in that broad application of methods as long-term orientation, backcasting, transdisciplinarial dialogues etc., in special cases they still have a “stand alone” character worldwide.

In Sweden a new 21st century program outgoing from the study "Sustainable Sweden 2021" is also working with the backcasting approach. To obtain sufficient commitment for long lasting viable action and research & development programs it's necessary and of vital interest to organize broad co-operation across different scientific disciplines and economic sectors but also between private parties, public administration and science & technology. Such co-operations were organised successfully in the UK foresight programs (Rawlins, 2000), in the Portuguese program “Industria Y Tecnologi” (Gavignan, 2000), in the Austrian Technology Delphi report (1998) and appears in almost all other European foresight or Delphi projects. This is also the case in a New Zealand foresight program (Reeve and Gandar, 1999) in which additionally a backcasting approach was followed to develop national development policies for a medium term period of 15 years. As a conclusion one could say, that altogether useful experiences are gained in the last years.

Guiding visions and backcasting as success factors. It was often observed that the backcasting approach is acting as a key-tool and important mean to develop creative steps towards sustaining systems. Backcasting means that in contrast with forecasting, where the prolonging of a certain trend stand in foreground of the technique, the discussion starts from the future to the present, starts with the formulation of a guiding vision and in a narrower sense from need to product. At the same time - by using the methods of "visioning" and "backcasting" - profitable short term opportunities were evolved.

One of the main aspects of innovation processes for a real system renewal concerns the design and architecture of the process itself. Ranging from small scale up to supranational such programmes / processes may be composed by combining experiences gained up to now in a transdisciplinarial way (Häberli et al., 2000). Integration of different domains of knowledge (disciplines, sectors, institutions) proves to be essential to obtain viable results and broadly supported development processes. The program-design should help to overcome a number of sincere dilemmas, bridge the different sectors and problem-situations and describe the necessary attitudes of actors and stakeholders to initiate substantial innovation processes (Jansen, 2000).

EU - policy options and barriers. An important question is whether and how the policies of the member states and of the EU itself can be directed to initiate innovation processes to develop sustainable options for the future. On the basis of a general future orientation on the EU level, a framework for innovation processes in respectively domains of need, in economic sectors and in different regions can be developed. Policies to initiate such innovation processes should recognise a double approach: top-down and bottom–up. Changes in societal systems and changes in governmental structures and procedures may run parallel in the sequence optimisation – improvement - renewal and vice verse.

Another aspect has to be considered: Sustainability oriented governmental policies pointing to systems renewal differ essentially from more traditional environmental policies pointing to systems optimisation and improvement. The degree of uncertainty, the scope of action, the accentuation in the sequence from production process to need fulfilment result in essentially differing driving forces and effect of administrative incentives imply a different role and attitude from government. Technology forcing by setting higher future standards may only lead to systems optimisation or improvement in a time scale up to middle long terms. Such odds given will not evoke private parties to undertake the risky development of system renewal. Government can forbid private parties to act irresponsible but not command to take future risks of development.

Against this background and in picking up the list of chapter 9 - the special characteristics of systems renewal processes - governmental parties have to play an active role in:

- handling uncertainties and risks in long term options and challenges,
- developing new roles and forms of co-operation between market, science & technology, NGO's, public administration and government
- involving and participating a representative sample of actors and stakeholders in such dialogue and actions processes (e.g. Local agenda 21)
- bridging between the given driving force of market competition and the necessity of new form of co-operation and trust
- arranging and establishing crossings of sectoral borders.

Incentives have to create a new understanding of responsibility for the future. All this requires a fundamental but achievable changing in the role of politics and governments. With respect to this new field of activeness and as a basis to set up long term system renewal programs, governments have to take responsibility for the consensual development of common shared guiding visions (future orientations). Further they have to learn how sharing risk with private parties in developing science and technology in broad long term system renewal development programs. Participating and co-operating between relevant stake holders and developing structures and opportunities for participation of non industrial stake holders (NGO's etc.) are additionally of essential importance in sustaining future processes.

Meeting these demands requires a change in governmental attitude and structures in new forms of public management (Bemelmans et al., 1999). In time and intensity these changes may run parallel to the subsequent changes in systems from optimisation on the short term up to renewal at the long term view.

Moreover the implementation of processes for sustainable technology development needs also creative incentives as for instance an education and awareness campaign leading to certain wants and market trends; the global taxation of resources and energy use (eco-taxes); new indicators for measuring real public welfare as for example the ISEW (Hochreiter et al., 1995); a new calculation of terms like return of invest, share- and stakeholder value as demonstrated by the Dow Jones Sustainability Group Index (DJSGI, 2000); building capacity in educational systems (Ehrenfeld et al., 2000) like signing, implementation and practise of the Copernicus Charter; new forms of cooperation and dialogue e.g. the "Dutch approach". But with all this we should never leave the main challenge of the next century and the final aim of all efforts out of mind: fulfilling all social and human needs in dignity by maintaining evolutionary capacity.

Vision without action is just a dream.
Action without vision is just passing time.
But vision with action can change the world!

Joel Barker, 1988

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