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Policies for Social Learning: "Bounded Socio-Technical Experiments"

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Abstract

Most cities around the world are highly unsustainable, either due to social problems (poverty, inequality) or due to over-consumption and production. These problems are highly persistent due to structural lock-in and due to the dominant culture and value systems. A transition to more sustainable cities implies deep changes in technology, infrastructure, institutions, consumption patterns, lifestyles and values.

Traditional policies often fail to address these issues and lack the instruments to engage in such deep change processes. New instruments and new coalitions of actors are necessary in order to bring about the necessary socio-technical and economic changes. In many places in the world the contours of these new coalitions are visible: they connect business with civil society and governance, they connect local with global issues, and they connect seemingly disconnected issues. However, many of these efforts are fragmented and many lessons learned get lost because of discontinuity and fragmentation.

The central question to be addressed is how to initiate and facilitate deep change processes in cities in the direction of sustainability. These change processes, often called ‘regime shifts’ or ‘transitions’, are multilevel, multi-scale, multi-actor, and multifaceted. They are by definition difficult to manage centrally, and thus are decentralized and often bottom-up. They consist of many activities in policy making, social and technical innovation, planning, infrastructural change, social movements, etc.

This paper makes the point that social learning is the essence of transition processes towards sustainability. Social learning occurs often through external crises but also through small-scale experimentation with new technologies, services, and social arrangements. In this paper we present a conceptual framework for social learning in so-called “Bounded Socio-Technical Experiments”, based on Schön, Fischer, and Grin and Van de Graaf, and apply this to cases in personal mobility and green housing in cities in the Netherlands and the USA. We conclude by making the case for multi-level policies aimed at fostering learning in small-scale experiments and at connecting and diffusing this learning across different scales and local situations.

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1. Introduction

In this paper we address the question how to foster and catalyze transitions towards sustainable cities. Most cities are not sustainable; some are aiming to become more sustainable but these efforts often lack the dimension of *global* sustainability and *equity*. In other words, the global footprint of these cities in other, often less developed parts of the world, is hardly taken into account.

Most cities in North and South are locked in into unsustainable infrastructures, institutions, social arrangements, technologies, and practices, making it very hard to engage in transitions towards sustainability. In this paper we claim that social learning is necessary to break through the barriers to transition towards sustainability. We further propose three approaches to bringing about social learning: small-scale experimentation by multi-stakeholder alliances, aiming at introduction and diffusion of innovative technologies, services and social arrangements; visioning; and backcasting.

A vision should inspire social actors to investigate and test attractive alternatives- from technology to behavior to culture and institutions. Visions should not be seen as 'blueprints' for the future, or alternatively as utopias that may never be reached.. There often is a creative jump, which constitutes the difference with trend-following scenarios. Visioning processes, especially when they are conducted in multi-stakeholder settings, are excellent venues for learning, providing at the same time the necessary directionality for small-scale experimentation.

Backcasting can be defined as first creating a desirable (sustainable) future vision or normative scenario, followed by looking back on how this desirable future could be achieved, and then defining and planning follow-up activities and developing strategies leading towards that desirable future. This process may identify opportunities for qualitative change between now and the future. Backcasting has been proposed and tested in the Netherlands as a promising participatory planning approach to identify and explore innovations towards sustainability (on a system level).

While in the 90-ies visioning and backcasting, together with illustrative processes, were seen as sufficient to get a sustainability transition under way, recent research has shown that in addition to that social learning through what we call Bounded Socio-Technical Experiments (BSTE) is necessary. In this paper we further elaborate the concept of BSTE by showing how social learning can take place on four different levels of discourse. By reviewing and expanding the literature on social learning we are able to show how in these specific situations higher order learning processes take place.

We then review a multi-stakeholder visioning process in the Boston area, aimed at a livable Boston in 2030. We describe how Tellus Institute tries to infuse notions of global sustainability and equity in this process. We further describe, as an example of how a BSTE can contribute to this process, a socio-technical experiment in green building in South Boston. We thus give examples of how visioning, back-casting and socio-technical experimentation can be the ingredients for getting a sustainability transition under way. To conclude, we review policy options to foster visioning, back-casting, and socio-technical experimentation.

2. Sustainable cities

Around the world, many cities, towns, villages, and communities aim to become sustainable. Highly visible examples include Curitiba (Brazil), Bogota (Columbia) (Transmileneo, 2003), Portland (Oregon, USA), and many cities in Europe. In Europe, the Aalborg declaration is now supported by 110 cities within Europe (Aalborg declaration, 2004). ICLEI (International Council for Local Environmental Initiatives) is now supported by 400 local governments and many more NGOs; 47 local governments in the USA, 180 in Europe subscribe (ICLEI, 2004). 147 cities in the USA subscribe to the CCP, the Cities for Climate Protection Campaign. (CCP, 2004)

On the local level, many communities are active in pursuing alternatives, ranging from green products and fair trade products to solar energy houses. Ken Portney investigates in his book “Taking Sustainable Cities seriously” (Portney, 2003) the sustainability plans and actions of 31 cities in the USA that claim to have sustainability initiatives. He has developed an index to measure the seriousness of sustainable cities initiatives, where Seattle stands nr 1 and Portland nr 6. Richard Register describes how to design sustainable cities, with many interesting ideas and suggestions on possible solutions (walkable cities, reclaiming nature, three-dimensional building) and on the process how to reach such solutions in practice (Register, 2002). Gwendolyn Hallsmith describes the process how to transform communities into sustainable communities (Hallsmith, 2003) Sarah James in her book “The Natural step for communities” has done the same, based on the principles of “The Natural Step” and presenting many examples from Sweden and the USA (James et al, 2004).

Outside the specific area of towns and cities, many other writers and thinkers have addressed the challenges of unsustainability, sustainable development, and scenarios for transitions to sustainable societies. Unfortunately, the dominant global trend is still very unsustainable: the world population increases, production and consumption per capita are growing, in industrialized countries but even more so in industrializing countries like India and China (Meyers et al, 2004), and global environmental pollution and degradation are increasing fast and reaching unsustainable levels. The drivers of these changes, the world economic and trade systems, worldwide population growth, and unbridled consumption, together with gross inequalities in income and power, are hardly effectively addressed, neither on the local nor on the global level.

Why addressing sustainable development on the level of cities rather than on the global or on the very local (community) level? Without doubt, initiatives on all levels are necessary to reverse the trends of unsustainable development. On the global level, the UNO and many global NGOs address issues of unsustainability, for instance in the MDGs, the Millenium Development Goals (UNO 2004). However, the process of reaching these goals is very slow, and many see the national states as either corrupt or at least unfit to facilitate such processes quickly enough. Many global institutions such as the World Bank, the IMF, the WTO, and the international money transactions dominate the scene and steer developments into unsustainable directions.

In the world’s cities the majority of the population lives and certainly will live in the coming century. In the cities the concentration of unsustainability activities are highest, such as high levels of consumption, unsustainable buildings, urban sprawl and high automobile use, and these developments continue in unsustainable directions. Cities depend to a high extent on the surrounding countryside, and on the world at large for their supply of raw materials, foodstuffs, and energy provision. They export an enormous amount of waste and pollution to elsewhere. It thus makes sense that cities start to reflect upon their role in sustainable development and start to think about how to become more sustainable. Another good reason is that there is a high concentration of intellect, capabilities, and creativity in cities (Register, 2002).

Despite all efforts, the dominant model of cities in the world is that of unsustainability, with many problems that are highly interconnected: poverty, pollution of air, water and soil, crime and unsafety, drags trafficking, racial tension, lack of good education, bad housing, congested traffic, and urban sprawl. Moreover, many cities are growing at an unprecedented rate, sucking in poor landless farmers from the countryside, and from further abroad, creating slums, high levels of unemployment and crime. But even cities in the highly industrialized countries where problems of poverty are less outspoken, there are a lot of similar problems. Moreover, these cities have on average such high levels of production and consumption that the CO2 emissions from their energy consumption are a factor 4-10 above levels of sustainability. Their consumption patterns are such that their ecological footprint is a factor 5 larger than the world average, and a factor 6 higher than a global sustainability level.

What would make a city or a town sustainable? There are many definitions of sustainability, many sets of principles, most of them sharing an environmental, a socio-cultural, and an economic dimension. John Ehrenfeld makes a strong distinction between sustainable development, which he sees as a sort of improved economic development, and sustainability, which implies for him a large-scale transition. He defines sustainability as "….“the *possibility* that human and other forms of life will *flourish* on the Earth *forever*." (Ehrenfeld, 2004). This definition certainly requires a breach of trend on many dimensions.

Based on our own experience and on the literature cited above we like to present the following principles of Sustainability in general:

Take a long-term and all-global view of a sustainable and socially equitable society
Place sustainable fulfillment of human needs in the centre of the economic system
Follow nature's principles as much as possible
Close loops, avoid extraction from and emission to the biosphere
Connect the global long-term view with local concerns and culture
Take decisions at the lowest possible level and as democratically as possible
Learn from small-scale local experiments and concrete examples and diffuse them widely
Create collaboration between civil society, business, and governments

In Europe, especially in the Netherlands and in Germany, scholars have called for a factor 4-20 increase in eco-efficiency in order to meet the requirements of sustainability. Von Weiszacker has called for a factor 4: doubling wealth, halving resources, by means of clever design and of shifts from products to eco-efficient services (Lovins et al, 1998). The Carnoules declaration calls for a factor 10 increase in resource productivity (Factor 10 Club, 1995). In the Netherlands, the Dutch government launched the program "Sustainable Technological Development" (1993-2000) based on the challenge of a factor 20 increase in eco-efficiency in the fulfillment of needs (Vergragt et al, 1993, 1994, 2001; Weaver et al, 2000). This was based on the IPAT Equation (Ehrlich et al, 1974): if within 50 years world population doubles, consumption and production increase by a factor 5 due to higher standards of living, and ecological burden needs to decrease by a factor 2 per capita, needs fulfillment needs to be accomplished by a factor 20 less environmental burden per capita. It is clear that such high reduction factors cannot be reached by technological innovation alone (Rajan, 2004). Changes in behavior, in consumption patterns, in institutions and in the economic system will be necessary to accomplish that.

Leadership of those change processes has to come from the highly industrialized countries, in close cooperation with strongly developing countries like India and China. In the industrialized countries the knowledge and funding are available to investigate and to research alternatives for the present production and consumption patterns. Much has been reached in the last 30 years in the sphere of industrial production: many polluting industries have cleaned up by end-of-pipe technologies, process-integrated technologies, radical innovations in new technologies (Moors et al, 2004), and system innovations.

However, the appearance of new forms of pollution (massive air traffic, mass tourism), the persistent dominance of the car, and increasing levels of consumption have more than annihilated these advances. Although on some specific areas progress has been made (ozone layer depletion, SO2 emission), the increasing indication of man-enhanced global warming by greenhouse gas emissions, and the alarming decrease in biodiversity have added a new challenge to sustainable development. Add to this a fast growing population of the earth, and quickly increasing standards of living in countries like India and China. The persistent high prices of oil are only a first manifestation of what is going to happen in the next 20-30 years.

We should hope that the developing countries will ‘leapfrog’ and will avoid the mistakes that have been made in the industrialized countries, which are highly locked-in in their present state of unsustainability. However there are many disturbing signs that India and China are quickly following the bad example of the USA and other highly industrialized countries. However, India and China are still in a much better position to avoid mistakes being made in the industrialized countries, if they start early enough to follow a different development path. But the USA, Europe, Japan and Australia need to lead the way and to mobilize forces that lead into a different direction.

In the Netherlands, the Dutch government has made “transition management” the core of its sustainability policy. Transitions are “....long term, continuous processes in which a society or a subsystem changes fundamentally; interconnected changes, which reinforce each other in technology, the economy, institutions, ecology, culture, behaviour, and belief system….” (Kemp et al, 2001, 2002; Rotmans et al, 2001, Geels 2002 a,b). In the National Environmental Policy Plan (NEPP, 2001), four areas of transitions are indicated: energy, transportation, agriculture, and biodiversity. Up till now, only the energy transition has shown some progress; however, most of the progress has been made in the field of innovation and diffusion of technology. Little attention has been paid to persistent patterns of unsustainable consumption.

In the USA, Tellus Institute has launched an initiative called “Great Transition Initiative” (Tellus Institute, 2004). It is based on an essay (Raskin et al, 2002) in which the need for a “Great Transition” is clearly endorsed by years of scenario work. In “Great Transition, the Promise and Lure of the Times Ahead,” it has been argued that we have reached the "planetary phase" of civilization. We are living at the onset of another global "Great Transition," but its direction is yet unclear. A number of scenarios has been outlined, many of them are not very attractive from a quality of life or an ecological point of view. The only acceptable scenarios would be Policy Reform, Eco-communalism, and New Sustainability. Policy Reform presupposes that a combination of government policies and technological innovation can solve the globe's ecological problems; however political will has been lacking to implement change. Eco-communalism does not have the answers in a quickly globalizing world. In the "New Sustainability" scenario, a deep change in values, life-styles, institutions, the economy, and production and consumption patterns, together with solidarity among rich and poor, will eventually lead to a more sustainable global society. For this transition, the thrust will come from informed and concerned global citizens, rather than from NGOs, governments, or businesses. It is a long-term process that will take decades but which needs to be started now, because time is quickly running out.

A Great Transition could be brought about by initiative from global civil society, which could align the many dispersed initiatives and action groups addressing elements of unsustainability in an uncoordinated way. A recent workshop at the Boston Social Forum (July 2004) has shown that there is also clear interest to bring the transition to the local level of cities.

How to start a process that would lead to the envisaged sustainability transition? Visioning, backcasting, and socio-technical experimentation, together with higher order learning, are thought to be the key ingredients. Visioning and Backcasting have been developed and utilized in the Sustainable Technological Development (STD) program (Vergragt et al, 1993, 1994, 2001; Weaver et al, 2000), and in the EU funded project "Strategies for the Sustainable Household (SusHouse), 1998-2000 (Vergragt, 2000; Green et al, 2002, Young et al, 2001, Quist et al 2000, 2001).

Visions are powerful devices that can orient and structure action and behavior. Berkhout (2003) calls visions "Pictures in our heads that frame behavior", "Cognitive structures that orient behavior and defines roles" and "Metaphorical structures, coherent with underlying values". He focuses on the role of 'technological visions' (but it could be applied to all kind of visions) as "...mapping a 'possibility space'; a heuristic device-problem defining and problem-solving; a stable frame for target setting and monitoring progress; a metaphor for building actor-networks; a narrative for focusing capital and other resources......Every plan of action requires an image or a vision- so new visions are continually generated..........Visions come to be articulated and diffused for two reasons: Their intrinsic validity and attractiveness; the power of constitutive interests; Visions with greater 'interpretive flexibility are more effectively diffused". Shared visions may act as means to unify disparate interests by creating an attractive alternative for the present situation.

The origin of *backcasting* goes back to Amory Lovins, who proposed backcasting as an alternative planning technique for electricity supply and demand in the 1970s (Robinson 1982, Anderson 2001). Vergragt and Jansen (1993), inspired by the Swedish practice, mentioned backcasting as part of the philosophy of the STD program. They described the basic idea (1993: p136) as *to create a robust picture of the future situation as a starting point, and start to think about which (technical and other) means are necessary to reach this state of affairs. Such a view of reality is not a scenario or a* *product of forecasting, but should be seen as a solid picture that can be accepted by the technological spokesmen right now.* Elsewhere, Vergragt and Van der Wel (1998: p173) go beyond the desirable future – like Hojer and Mattsson (2000) also did – and emphasize implementation and planning for action. *Future visions alone are not enough: Backcasting implies an operational plan for the present that is designed to move toward anticipated future states. Backcasting, then, is not based on the extrapolation of the present into the future – rather, it involves the extrapolation of desired or inevitable futures back into the present. Such a plan should be built around processes characterized as interactive (many stakeholders are involved) and iterative (feedback is continuous between future visions and present actions).* Elsewhere, Weaver et al (2001, p74), reporting on approach and results of the STD program, describe backcasting as a possible tool for establishing shared visions of desirable future system states and for securing a 'systems' perspective on the transition process, while it can also be of help in defining feasible short-term actions that can lead to trend-breaking change.

The common outcome of these projects is that it has been relatively easy to develop sustainability visions of the far future together with stakeholders in interactive creativity sessions in which knowledge and experience were combined with creativity (see also Partidario et al, 2002). Even interactive backcasting has been relatively successful, in which stakeholders have tried to translate challenges of future sustainability visions into concrete projects in the present (see also Quist et al, 2003, Kerkhof, 2004). However, the concretization of visions into action plans and innovations, let alone into first steps of system innovations or transitions, has up till now been disappointing, and can hardly been seen as the first steps towards a large scale transition.

So the challenge is to translate the principles of Sustainability, the challenge of factors 4-10-20 eco-efficiency, and the ideas on transition management and on the Great Transition, towards the level of cities or urban areas and into a concrete and workable form. For this we introduce the concept "Bounded Socio-Technical Experiment". In the next section we go deeper into the issues of social learning and socio-technical experimentation.

3. Bounded Socio-Technical Experiments and Learning: a conceptual approach

The term Bounded Socio-Technical Experiment (BSTE) denotes a project exhibiting several characteristics. (see also Brown, Vergragt, et al, 2003) It is an attempt to introduce a new technology or service on a scale bounded in space and time. The time dimension is around five years, while the space dimension is defined either geographically (a community) or by a number of users (small). BSTE is a collective endeavor, carried out by a coalition of diverse participants, including business, government, technical experts, educational and research institutions, NGOs and others. There is a cognitive component to BSTE in that at least some of the participants, and definitively the analyst, explicitly recognize the effort to be an *experiment*, in which learning by doing, trying out new strategies and new technological solutions, and continuous course correction, are standard features.

A BSTE provides an opportunity for testing the feasibility of a new technology or service before it is ready to enter the open market. Similarly, a BSTE allows for development of new social arrangements among actors, and to consider them as templates for other societal contexts. Finally, a BSTE is a way to draw actors into the sustainability agenda who would otherwise not see a place for themselves in the types of projects in technological and system innovation that are often sponsored by powerful corporate, governmental, or NGO entities.

A BSTE is driven by a long term and large-scale vision of advancing the society's sustainability agenda, though the vision needs not to be equally shared by its participants. Its goal is to try out innovative approaches for solving larger societal problems of unsustainable technologies and services. This latter characteristic distinguishes a BSTE from, for example, solving a particular environmental problem in a community (such as alleviating pollution through traffic control) or from a strictly market-driven introduction of new technologies and services (for example, introduction of alternative electric powered vehicles, such as Gizmo, Sparrow and many others (Buckley et al, 2003). On the other hand, small-scale environmental projects can be turned into BSTEs, where learning is enhanced and monitored (this would be a form of action research), by way of introducing a context, a vision, or an environmentally-driven new technological component.

A successful BSTE creates a functioning, socially-embedded new configuration of technology or service which serves as a starting point for further innovation or for diffusion, or which can inform the policy making process. An obvious indication that a BSTE is successful is when this new configuration first meets the initial expectations, and then is widely replicated and becomes a commercial success. To serve the goal of a sustainability transition, changes in societal institutions, infrastructures, and relationships among pertinent societal actors should accompany such a wide-scale adoption.

Another, less obvious (and harder to demonstrate empirically), measure of BSTE's success is diffusion of ideas embedded in that particular project beyond its boundaries and subsequent stimulation of other socio-technical experiments. In our earlier case analyses we found, for example, that when ideas from a BSTE concerning a technological innovation in individual mobility were introduced to an unrelated project of solving traffic problems in a distant island vacation resort in the Netherlands, it led to re-conceptualization of the latter project and subsequently to very different alternative solutions than originally considered.

A third indication of BSTE success is the occurrence of higher order learning among its participants. We use the term higher order learning (also referred to as conceptual or double loop learning) (Argyris et al, 1994; Senge, 1990, Keohane et al, 1989, Hall, 1993) to denote one or more of the following processes: Participants re-examine, and possibly change, their initial perspectives on the problem which the particular project seeks to solve, or the societal needs the projects seeks to meet as well as the approaches and solutions; participants examine and place the particular project in a broader context of pursuing a sustainable society; participants examine, and possibly change, their own perceived roles in the above problem definitions and solution; participants change their preferences about the social order and the beliefs about best strategies for achieving them; participants change views on the mutual relationships among the participants relative to the specific project or the broader societal context, including mutual convergence of goals and problem definitions.

Higher order learning entails a radical change in approaches to interpreting observations (interpretive frames) and to solving problems and advancing objectives. The term “higher order” denotes what in organizational sciences has been dubbed “double loop” (Argyris 1977; Argyris and Schön 1978), or “generative” learning (Senge 1990), and in policy sciences as “conceptual” learning (Glasbergen 1996). It generally involves changes in the assumptions, norms and interpretive frames that govern the decision-making processes and actions of individuals, communities and organizations, or that underlie the policy discourse. It occurs through reflection and self-evaluation. Higher order/double loop/generative/conceptual learning contrasts with lower order/single loop/adaptive/technical learning, respectively, in which problems are corrected or policies altered without changes in problem definition, interpretive frames or in norms and values.

Learning occurs through a feedback-stimulus mechanism, when the existing, well accepted, time-tested and trusted interpretive frames and competences receive feedback on their performance in solving a problem or advancing specific objectives. If, as a result of this feedback, it becomes apparent that the desired results are not forthcoming, these cognitive constructs become subject to reassessment and, if necessary, are replaced with new ones. A sense of urgency is an important facilitator of learning because it forces repeated trying (and failing) that is central to the learning process.

This broad concept of feedback-stimulus is consistent across a wide range of disciplinary writings about learning, from cognitive sciences (Schön, 1983) to organizational sciences to policy sciences. On the level of organizations, the stimuli necessary for higher order learning come from threats to organizational survival and success, failures, disasters and other surprises (Argyris, Sitkin). Senge (1990) additionally writes about using mental model building and structured interactions, scenario building, role playing, visioning, system thinking and other group techniques that generate feedback on the accepted assumptions and behaviors, as the means to stimulate higher order learning in organizations (see also the review by Easterby-Smith (1997)). In this paper we draw on this approach to learning when we discuss the role of visioning in socio-technical experiments.

Wenger uses a “community of practice” as a unit of analysis in order to examine the mechanisms by which external stimuli induce learning in social organizations, both formal and informal. In Wenger’s language, the feedback process that is central to learning occurs through interaction between the deep competency possessed by a community of practice and the experience it acquires by interacting with the outside world. It is these boundary processes that produce learning. Several factors can enhance the learning at the boundaries: having something to interact about, such as a specific project or a problem to solve; openness to self-reflection and reassessment by the members of the participants in the boundary processes; and an ability to communicate in a common language.

Like organizational and cognitive sciences, the policy sciences attribute learning to the presence of feedback loops between the existing belief system and interpretive frames, and new experiences. Authors such as Lee (1993) and Van Eijndhoven (2001) emphasize the role of new knowledge in providing the feedback, while Sabatier (1993), Wildawski (1990), Glasbergen (1996) and Schön (1994) emphasize interaction among groups with different belief systems and interpretive frames as the means for learning. There is a widespread agreement that crisis, a sense of urgency, and the availability of platforms for interaction are important facilitators of social learning (Birkland 1997;

Schön 1994). Paquet (1999) advocates social experimentation as an effective inducer of the processes leading to social learning.

In a study of the anatomy of intractable policy controversies, Schön, (1994) observes that learning (and conflict resolution) occurs through multilevel interactions among the adversaries, and only when an issue is re-framed so as to accommodate the different interpretive frames of the adversaries. Like Schön, Fischer (1995) also uses the idea of multilevel discourse in public policy. This author identifies four levels of increasingly higher order discourse: technical, on the level of specific tools, costs and benefits, and outcomes in policy implementation, all within a specific set of objectives; contextual, on the level of problem definition within a given background theory and interpretive frame; systemic, focusing on goals and objectives in relation to societal needs; and ideological, on the level of fundamental beliefs about the social order. In this study we draw on Schön's and Fischer's multilevel interactions to map out the learning processes in socio-technical experiments.

We conceptualize social learning from BSTEs as a process of diffusion. The participants in BSTEs serve as idea brokers (to use Wenger's terminology) who transmit ideas and knowledge into their own communities of practice. Social learning then occurs as a result of interactions and discourse – proceeding on multiple levels – between the new ideas and knowledge and those that are well established within the communities of practice. Many social learning theorists have emphasized the fact that social learning involves both cognitive processes and social interactions. The cognitive processes includes reflection, reassessment and reframing on the individual or group level, while the social processes involves transmission and diffusion of new ideas and knowledge (see, for example Luthans and Kreitner 1985; Granovetter 1973; Bandura; Hamblin 1979). Rogers' well-known work on diffusion of technological innovation (1985) also drew on these concepts.

BSTEs have several characteristics that are conducive to higher order learning. The participation by heterogeneous actors who represent different organizations, communities of practice and institutional affiliations assures the presence of a range of interpretive frames. On the other hand, the very act of choosing to participate in the experiment suggests a willingness on the participants' part (at least some of them) to interact with each other and with each other's interpretive frames, and thus to create the "boundary processes." The vision of sustainability, which is the driving force of at least some participants, has the potential to provide a platform, an umbrella, for re-framing the clashing interpretive frames, should a conflict arise. By evolving around a specific tangible "thing" -- the innovative product or service – the project provides a boundary object (Wenger's terminology) and at least some rudimentary shared language for the discourse.

Other design features can be brought into the experiment in order to facilitate learning. These include: creating a sense of urgency; making deliberate efforts to encourage self-reflection and reassessment by and among the participants; and facilitating emergence of a common language. These features are not automatic in BSTEs. In fact, small-scale socio-technical experiments driven by the sustainability vision often lack the sense of urgency. This is because financial risks are often artificially lowered through government subsidies and are spread out among numerous actors. Furthermore, some coalition members might have low commitment to the success of the project and low stakes in the outcome.

Additionally, champions of bounded socio-technical experiments must also contend with two inherent dilemmas. It is not uncommon for these individuals to pursue their vision in the absence of strong backing from the organization each represents. We showed in the previous case studies that this ‘actors’ dilemma – an individual versus an organization – can lead to risk avoiding behavior in individual decisions on the part of the project leadership, which translates, in turn, into higher risks for the project. Another ‘actors’ dilemma inherent to BSTEs -- congruency of vision versus breath of support -- derives from the tension between the need to build broad base of support for the project and the need to create a common vision among the actors. The larger the number of actors the more difficult it is to create such a vision. (For example, in the TH!NK car case Schwartz (2002) identified more than 15 major institutional actors involved in the TH!NK City development). To seek clarification at the outset would be to risk a premature confrontation of different problem definitions, interpretive frames, or even fundamental value system, and consequently lead to disintegration of the fragile coalition, rather than learning. Deferring the clarification carries other risks to the project, such as: creating unexpressed tensions throughout the project; or diminishing the “boundary processes” by inadequate interaction or having the most committed participant(s) impose their problem definition and interpretive frame on the project.

On the other hand, Green and Vergragt (2002) have shown that structured visioning exercises may compensate for the lack of the sense of urgency.

We build on the work of Grin and Van de Graaf (1996 a, b) to conceptualize the learning processes in BSTEs. These authors applied Fischer’s and Schön’s frameworks of multilevel discourse to examine the learning processes occurring during constructive (or interactive) technology assessment. They followed the differences in problem definition and the approaches to problem solving within three professional communities who participated in technology assessment for wind power in Denmark: technologists, policy makers and business. Using the concepts of iteration and discourse, they showed how the discourse within each professional group proceeded on four levels (four orders of discourse). They suggested further (but did not show in detail) how multiple level interactions between different professional groups with different frames of meaning, background theories, and higher order belief systems would produce learning, starting with questioning of each others’ problem definition and thus directly and indirectly expanding the discourse to higher orders.

According to Grin and Van de Graaf, apart from major external triggering events, learning is indeed most likely to occur when different kinds of professional groups work on the same problem. The question arises how different professional communities (or ‘communities of practice’) can collaborate at all on a joint problem if they do not partake in shared frames of meaning. The answer is that different actors will have different problem definitions and different tools for problem solving, but they can collaborate if they accept each other’s problem definition as legitimate. Grin and van de Graaf call this ‘congruence’ but we prefer the term ‘dominant, or shared, problem definition’ (Vergragt 1988), which is recognized as legitimate by diverse groups.

Three features make the Grin and van de Graaf’s framework, originally derived from a study of technology assessment, useful for conceptualizing learning in BSTEs:

Focus on using new technology to solve a particular social problem or to meet a social need; Participation by various professional groups who bring different perspectives to the process; Focus on problem solving and a multi-level discourse as pathways to learning. The main difference is that BSTEs include a greater number and variety of active participants than the three professional communities considered by these authors -- including NGOs, local communities, financial sector, and others.

We conceptualize learning in BSTEs as a change occurring over time through mutual interaction among different participants who engage with each other for the purpose of introducing a new technology or service. The motivations of individual participants differ: some are pursuing a large-scale vision of sustainability; others are pursuing business or professional opportunities or are driven by a challenge of solving a new problem, while others may simply be ‘testing the waters’ of socio-technical change. A participant may be an individual (most likely connected to an organization), a professional community, a community of practice (company, NGO, trade group) or a specific interest group (organized local community).

The participants in BSTE bring with them diverse perspectives and competencies, which in turn affect the meaning they attach to the project at hand and the ways in which they seek to contribute to the project and its outcome. Factors such as professional training, self-interest, socialization through membership in political and professional groups as well as deeply held values and beliefs contribute to the variability. We group these differences into four levels (closely following Grin and Van de Graaf, Schön, and Fischer):

1. Problem solving according to pre-determined objectives;
2. Problem definition with regard to the particular technology-societal problem coupling;
3. Dominant interpretive frames (including appreciative systems, value systems and background theories)
4. Fundamental preferences for social order.

Of course, individual participants need not engage in a particular project equally at the four levels. For example, the discourse between technical experts mostly remains at levels 1 and 2, centering on the problem and the best (technical) solutions. In a discourse between technical experts and an organized community, however, differences in problem definitions may push the discourse to the second and possibly third levels, where technically oriented frames of meaning may contrast with socially oriented frames of meaning. When that happens, reaching a common understanding and a common strategy between the two groups (i.e. when they recognize each other’s frame of meaning and problem definition as different but legitimate) involves higher order learning.

Discourse at the first level to solve a defined problem generally includes tools that the participant seems fit for addressing the particular problem, such engineering analysis, cost-benefit analysis, risk analysis, and others. The discourse proceeds primarily within the participating groups, but may be between them, and relies mostly on professionally accepted norms. Learning at this level does not involve reflection on the objectives of the project, or questioning of the match between the social problem and the solution that the particular technology represents. This is first order learning.

The most intense interactions between different participants in BSTEs occur on the second and third levels. Each of the groups has a stable interpretive frame (level 3), often tightly linked to the preferences of social order (level 4). This is where the differences in problem definition, motivations for engaging in the project, individual interests and organizational missions, and perspectives on the particular technology become most clearly exposed and are most likely to confront each other. The nature and the extent of the resulting learning – of the higher order type -- depend on the form which that confrontation takes as well as the way it is managed by the BSTE participants. Generally, changes in problem definition are likely, while changes in interpretive frames are much less so.

Discourse at the fourth level rarely occurs, is unlikely to produce changes, and is most dangerous for a collaborative project. This is because the views of this order are very stable within each participant group. Rather than closing gaps in deeply held beliefs, an open discourse in this domain may lead to a deadlock. Of course, differing views on the preferred social order do play a role in the overall process. They do so indirectly, by impacting the way individual participants interpret the meaning of the project *vis-a-vis* the private and public interests, or how they define a problem.

Table 1 summarizes the four levels of discourse and applies them to a specific case study we have described elsewhere: designing an alternative individual mobility solution, a “bike-plus” called Mitka (Brown et al. 2003). The left-hand column lists the four levels at which BSTE participants interface with a project and each other (orders of discourse). The remaining columns give examples for each level, using the empirical data from the case study. Mitka (an acronym derived from ‘mobility solution for individual transportation on short distances’, in Dutch) is a roofed three wheel human-powered vehicle with an electric engine that doubles its power. It has a maximum speed is 30-40 km/hour, and tilts and steers automatically. Mitka has a sleek attractive shape with a natural position of a driver’s body. It was intended as an alternative to a car for commuting on distances up to 25 kilometers.

The Mitka project had four key participants. A research group from Technical University of Delft (TU Delft) specializing in engineering designs for sustainability saw the project as a step towards introducing more sustainable solutions to transportation needs. The group understood that in order to be successful, a technologic artifact must be responsive to social and cultural preferences. TNO Industry (TNO) is a major Dutch organization for applied research in technologic innovation in industry, funded from public and private sources. For TNO, Mitka was primarily a government-funded opportunity to address a technologic challenge, although the opportunity to collaborate with a dynamic and innovative academic research group on a sustainability project also played a role.

Table 1. Types of engagements by participants in the Dutch BSTE with Mitka

	Level of discourse	TU Delft	TNO	Nike Company	Gazelle Company
1	Problem solving	Design vehicle for short-distance personal transportation based on list of requirements	Find specific technological solutions for steering, tilting, stability, weather proof; Develop appropriate markets	Participate in project discussions; No financial commitment	Collaborate with Nike Company to enhance image; Bring in technical know-how; Participate, but no financial commitment
2	Problem definition for particular technology-society coupling	New vehicle should be energy efficient, safe, fast, reliable, match lifestyles and infrastructure, have potential for diffusion	New vehicle should be fast, power assisted, weather protective, sleek, moderately radical, attract new markets	Solve parking shortage for commuting employees; Enhance environmental profile	Develop new markets among short distance car commuters; Enhance technological and environmental profile
3	Dominant interpretive frame	Sustainable transportation system must include smart and energy-efficient alternatives to vehicles	Sustainable transportation system must include smart and energy-efficient alternatives to vehicles	High profile environmental project benefits company image; Project peripheral to Nike core business	Environmentally-driven innovation provides new market opportunities
4	Preferences relative to social order	Social behaviors can be changed for common good through smart innovations; Universities are agents of change for social good	Technological innovation is key to meeting societal goals; Sustainability is one of societal goals	Business should be socially and environmentally responsible	Continuity of business requires new markets and products

Nike Europe, a multinational manufacturer of youthful athletic personal products, saw Mitka as potentially easy and low risk way to alleviate the shortage of automobile parking spaces for its employees. The company was also attracted to the environmental aspects of the project. Gazelle Company, a leading Dutch bicycle manufacturer was seeking to expand its mature markets, and who attracted by the opportunity to associate with the brand name of Nike.

Table 1 shows that the participants in the Mitka BSTE did not share the problem definition in this project, guided by their different dominant interpretive frames and ultimately preferred social orders. Furthermore, as described in detail elsewhere (Brown et al 2003), the fragility of the coalition -- attributable partly to the low level of financial commitment by the two companies and the less than optimal project management – lead to the absence of a shared problem definition and a recognition of each others' problem definition as legitimate. The result was that several opportunities for higher order learning were missed. We then concluded that regular visioning exercises, in the form of workshops, a plan for monitoring the learning processes, and introduction of the sense of urgency by requiring financial investments from Nike and Gazelle, could have alleviated these shortcomings.

Despite the missed opportunities, higher order learning nevertheless took place in this BSTE. First, for the first time Nike considered individual mobility solutions as a potentially promising direction for defining its core business, while Gazelle reconsidered its core business to possibly include environmentally sensitive human powered inventions. Second, through the network of some of the participants the idea of this bike-plus individual mobility solution played an important role in providing a surprising solution to a transportation problem in a very different and unrelated project, on a resort island of Texel. Third, the Mitka project drew into it new and unexpected business participants who, as a result, redefined their own core businesses. One of these was a major Dutch insurance company which has initiated a new line of business of solving employee transportation problems for its business clients, and which as a result enlarged its menu of options to include bike-plus vehicles.

4. The Case of Boston

As we have stated in the introduction, transitions to sustainability on the level of cities and urban agglomerations can be fostered by a combination of the following elements. First of all, a city needs to develop a long-term vision based on sustainability and global equity. It is not enough that this vision has elements of local sustainability and equity; for a truly sustainable city global sustainability and equity are normative elements. No city can call itself sustainable if it depends disproportionably on other areas in the world for its needs fulfillment. In order to foster social learning, a sense of urgency should be part of this vision. Although it has a long time horizon, it needs steps towards implementation as quickly as possible.

Secondly, the development of sustainability scenarios, based on visions, but being more quantified, internally consistent, derived from available data as well as normative elements of a desirable society, are necessary ingredients in the translation from visions into short-term policies. Scenarios generate alternative pathways towards sustainability and form the bridge towards policy measures to be taken on the short term to bring about structural and cultural shifts.

Third, backcasting from those visions and scenarios is a necessary step to identify short-term actions. Backcasting is essentially looking backwards from a desirable future and identifying which structural and cultural changes or ‘paradigm shifts, or shifts in regime, are necessary to eventually get there. Where scenarios stress the continuity between the present and the future, backcasting stresses the qualitative changes that are necessary between now and then in order to reach towards future sustainability.

Fourth, in order to make qualitative change towards sustainability, social learning among stakeholders in “Bounded Socio-Technical Experiments is necessary. We have identified four levels of discourse in such multi-stakeholder experiments.

Fifth, diffusion of social learning in wider society beyond BSTEs may take place by connecting various different experiments, either by individuals moving to the next experiment, or by communicating between different experiments.

In this case study-in-progress we describe how the Boston Metropolitan Area Planning Council (MAPC) is engaged in a large-scale visioning process (MetroFuture) aiming at a future livable Boston area in 2030 (MAPC, 2004). Since 2003, MetroFuture organized a series of visioning sessions with a broad range of stakeholders to envision a future Boston metropolitan area in 2030.

As an environmental NGO and think-tank for sustainable development, Tellus Institute in Boston is launching the “Great Transition Initiative” aiming both at the global and at various local levels, including the greater Boston area as one of its targets. (Tellus Institute, 2004). A Great Transition calls for mobilizing and aligning social movements in order to achieve major change in behavior, institutions, culture, values, and technology driven by civil society in order to achieve sustainability.

In the Boston area there are many projects under way which might potentially be turned into BSTEs. In this section we focus on one of them, the development of a green building in South Boston.

Boston is a major city on the East Coast of the USA, traditionally a centre of shipbuilding, whaling, and trade, and more recently a centre of high tech industries and higher education. The Boston municipality has about 575 000 inhabitants, but the Boston Metropolitan area, consisting of 22 cities and 79 towns, has about 3 million inhabitants in an area of 1422 sq miles (about 3600 sq km). Every working day Boston’s population doubles by workers who work in the central city. Boston has a relatively highly developed system of public transportation, connecting some of the suburbs to the inner city. However, it has its share of problems around car transportation, including air pollution, congestion, and a high rate of urban sprawl.

Boston has been part of several sustainability initiatives. In 2001, the Conference of New England governors and E-Canadian prime ministers adopted a Climate Change Action Plan (New England Governors/ Eastern Canadian Premiers, 2001) in which they call for a reduction of CO2 emission of –75% on the long term (30-50 years). They ask the states and the provinces to come with implementation plans and policy. The State of Massachusetts issued its own Mass Climate Action Plan in which the target of -75% CO2 was repeated; the cities of Boston, Cambridge, and Brookline are members of the Cities for Climate Protection (CCP 2004); the Mayor of Boston started Green Building Task Force.

The Boston Metropolitan Area Planning Council (MAPC, 2004) launched its MetroFuture project in 2003. This large-scale participatory initiative will develop a *vision* for the Metro Boston region’s future and a *strategy* to get there. It will use public participation, data analysis and cutting-edge technologies to best inform and involve individuals across the region in this collaborative decision-making process. MetroFuture's first phase, known as Initial Visioning, will gather a tapestry of visions for the Metro Boston region’s future. From there on, the following phases will be walked through:

- Phase 2: an analysis of trends and creation of a baseline analysis for each dimension based on these trends;

- Phase 3: development of alternative scenarios for each dimension;
- Phase 4: creation of at least two integrated scenarios that combine dimension-specific scenarios into different visions; and
- Phase 5: development of an implementation strategy for the preferred vision.

Tellus Institute realized early 2004 that MetroFuture, being a large-scale and participatory program and process, lacked a vision on, or a framework for, global sustainability and equity. Although local environmental concerns like clean water and air, less congestion, and more green open space are certainly part of the process, the global connections are generally not made. The risk would be that a regional planning effort that does not include global sustainability as its framework would turn out to be obsolete in the coming years because of the growing importance of sustainability on the agenda of cities and urban areas.

After discussions with MetroFuture staff, and invited by MetroFuture, Tellus organized a workshop in April 2004 about the question how to bring global sustainability and equity in the MetroFuture process (Tellus draft workshop report, 2004). The objective of the meeting was to get broad endorsement for inclusion of a sustainable metropolitan Boston scenario in the ongoing MetroFuture regional planning process. In this workshop Tellus institute argued that global sustainability and equity imply a fair share for Boston of, for instance, CO_2 emissions and the ecological footprint. Taking into account the growing world population and growing affluence this would mean a CO_2 reduction of –75-85% within 30-50 years, and a reduction of the ecological footprint by a factor 5-6 within the same time horizon.

The participants acknowledged the need to look deeply at power issues and systemic economic change. They raised the issue of the structure of the U.S. economy, which, according to them, has shifted from being dominated by production to one that is now dominated by consumption. The participants agreed with the need for equity and fairness, but acknowledged that it is not a widely shared value; and thus some of them stated that cultural change is required. For instance, the transportation system is designed around car use (parking requirements, single use zoning), so even if we are able to make fundamental changes, there will be a considerable time lag. While the global perspective is important, focus is needed on the 101 cities and towns in the MAPC region. Hot button issues should be identified as leverage points for change; one example is the focus on “green” schools in the city centre to improve student health and performance, and to prevent emigration of well-to-do families with small children to the suburbs. Leadership is critical for making progress on sustainability at the local/regional level.

There was general agreement among participants supporting the importance of sustainability in the MetroFuture process and the need to create one or more sustainability scenarios. Ultimately, to be successful in involving people from all backgrounds in the MetroFuture process and implementation of strategies for change, people need to be engaged through their existing networks.

Following this workshop, MetroFuture is working with Tellus Institute and others to develop an approach how to bring a vision on, or a framework of, sustainability into the MF planning process. This may result in bringing in sustainability issues into each of the task forces that frame the scenarios for a future Boston. It also may result in developing alternative sustainability scenarios for the Boston Metro area.

Tellus Institute stresses the importance of a leading sustainability vision in the process of strategic action and implementation, and eventually in a transition towards a sustainable Boston. As an in-house exercise a small Tellus working group developed visions for transportation, the built environment, and nutrition, and is planning to develop others. The aim of this vision development is to show that attractive sustainable visions are indeed feasible, and also to start a stakeholder dialogue about the viability and acceptability of such vision. As an example the Tellus vision for transportation is shown in box 1. This vision is not yet finished; the aim is it to become part of an integrated vision spanning many dimensions.

Box 1 *(Tellus Institute, Boston, 2004)*
Vision on Sustainable Transportation in greater Boston

- *In the year 2050 the Boston metropolitan region has become a leading cultural and economic capital, famous for its environmental leadership. New land-use and transport practices are the great hallmarks of this new beacon of sustainability. A reduction of GHG emissions from transportation in the region have been reduced by 80% since 2000. The recently established coalition of local governments (or regional land use commission) developed and implemented a mix of policies aimed at rebuilding infrastructure, decreasing car use, and increasing public transit and other alternative modes of transportation, and stimulating citizens to live close to work, school, and recreation.*
- *Brownfields, vacant lots and many parking lots in Boston and other inner/core communities have been redeveloped with mixed-use in-fill projects; development restrictions and fees are placed on undeveloped areas within the region; and mixed-use zoning is adopted throughout the region to encourage a mix of residences, offices and commercial activities within walkable/ bikable distances from each other and from transit stations.*
- *Citizens are predominantly living and working near public transportation hubs. Public transportation is attractive because of high speed and frequency, high comfort, and convenient payment. Its use is encouraged by employers who offer free or reduced cost transit passes as a benefit, and a high fraction of offices and workplaces being situated near transportation hubs. Easy access to transit stations is provided by an extensive MBTA car-sharing program, as well as pick-up shuttle services using electric vehicles, underground parking spaces near stations, and high quality provisions for bicycle storage.*
- *Individual car use has decreased as alternative public and private transportation options have become so convenient. Transit includes a number of modes bus rapid transit, rail, light rail, car-sharing, taxis, and ferry services. Walking, cycling, shared taxis, and bus rapid transit have become easy, attractive, quick, comfortable, and less expensive than driving and parking, especially in the inner/core communities. All public fleets and most private cars are hybrids or run on hydrogen that is produced from renewables or natural gas. Significant investments have been made in carbon sequestration projects within the region and outside it to reduce the net greenhouse gas emissions considerably. Electric and fuel cell bicycles are common to help overcome adverse wind and ascents; bicycle lanes are common on most major roads. Three-wheel electric covered bicycles (Mitkas) provide individual transportation for handicapped, elderly, and other individual users.*
- *Major highways (93, 95, 90, 1) are redesigned from single-car use with lanes for bus-rapid transit (BRT) and high-occupancy vehicles, and for (electric) bicycles, scooters, and Mitkas. One lane on either side is dedicated to BRT, and a second lane for passing*

BRT and high-occupancy cars only. Their use is stimulated by time-and place dependant congestion pricing. Some transit nodal points are attractively situated close to highways in order to facilitate easy access.

- *A large part of downtown Boston is closed for individual cars except certain categories (high-occupancy, all-electric or hydrogen vehicles; electric multi-occupancy taxis). In this area public transit is free; bicycle facilities are readily available (lanes, storing, zip-car-like renting system); and the long-needed rail link between North and South Stations is in place. There are rolling and covered walkways for pedestrians (arcades).The traffic light system has been modernized to promote pedestrian and bicycle use and safety. In a significant part of the city private cars pay a London-type congestion fee according to size and type of propulsion, thus discouraging use of SUVs and non-zero-emission cars.*
- *The quality of schools near public transportation hubs is very high due to new financing schemes (de-linking from local property tax), including vehicle insurance programs based on fuel type, size of vehicle, and efficiency. Close to schools high-quality recreation and sport facilities are situated, thus reducing need for transportation. Need for transportation is further reduced by extensive tele-commuting (at least 20 % on average) and increased e-shopping with alternative fueled vehicle fleets for goods delivery.*
- *Boston is an attractive city for its citizens and for visitors because it combines urban features — shops, cultural attractions, restaurants, schools, museums, with green features — parks, river, lakes, and coast at short distances, with good transportation services, without the nuisance, disruption, and impacts of reliance on private vehicles and large parking lots. Because of its public transportation infrastructure and mix of incentives it offers a wide variety of services with high accessibility within short distances.*
- *Public-private partnerships have realized innovative solutions by experimenting with new technologies. By including universities and technical institutes in research and development, new private high-tech enterprises developing innovative mobility solutions are thriving. Advanced information and communications technology (ICT) is widely used for road pricing, congestion pricing, fare payment, trip reservation, information and communication services, tele-working and tele-shopping, combining trips, and vehicles sharing.*

The quality and viability of this vision need to be further tested, in stakeholder dialogues, by environmental assessments (do we really reach a reduction of CO2 emissions by 75-85 %?), by technology assessments to search for unwanted side effects. Such a vision could be turned into a scenario, meaning a more detailed picture of the future, and one or more possible roads towards this future. This latter process is called 'back-casting', looking backwards from a desired picture of the future to the present, and design steps into the direction of this future (Robinson 1982, 2003, Vergragt et al, 1993, 1994, 1998, 2001: Weaver et al 2000)

Parallel to visioning, scenario development, and backcasting as done by planning agencies like MAPC, or by specialized NGOs like Tellus Institute, we need socio-technical experiments to foster learning processes about steps in the direction of the desired vision. These BSTEs could be set up by many possible combinations of stakeholders, from business, civil society, and government agencies. We however should acknowledge that many grassroots groups and local ngo's are already engaged in socio-technical experimentation in the region, which might eventually fit into the preferred future sustainability vision. Although many grassroots may be one-issue local action groups, there is a number of activities going on (not always known and certainly not well coordinated) that are lead by a broader vision and that might very well fit into a preferred sustainability scenario. Some of these local NGO groups have been invited to the above-mentioned Tellus workshop, and others have been identified through ongoing contacts and by such events as the Boston Social Forum, which was held on 23-25 July 2004, and where Tellus gave two presentations. The identification of these local groups and their inclusion into the process of implementation of a future vision or scenario is part of the Tellus-led Great Transition Initiative (Tellus, 2004).

In box 2 we describe an example of a BSTE that fits in a vision for a Sustainable greater Boston. The research of this Green building in South Boston is still in an early stage, so no definitive conclusions can be drawn from it.

Box 2

An unusual green building in South Boston

Project developer Fred is an unusual person: highly educated in philosophy and social theory, he is part of the generation of the 60-ies that developed a vision for, what we now call, a sustainable society. This vision concerns social equity, participatory democracy and user involvement in project development, and sustainable energy provision by fossil fuel reduction and renewable energy. He more recently created a vision for the development of Boston, which includes reclamation of old, industrial buildings and sites.

Fred now develops an old distillery building he bought in the 80-ies, into a complex of green buildings. They will partially to be used by artists who already live in renovated parts of the complex, and partially for high-end sophisticated buyers of apartments who will finance both the affordable housing for the artists and the green elements in the building.

The 'green' elements of the building include the architectural design, computer-steered louvers for lighting, a new heating, cooling, and venting system using solar energy, and cogeneration fueled by biodiesel that is a waste product from restaurants. Many of these technologies were developed in earlier projects that could not be realized. In order to implement this plan Fred created a business model that looks like a heterogeneous coalition of grass-roots movement (biodiesel collection , current tenants (mostly artists), companies (louver development, cogeneration, biodiesel refinery), architects, urban planners, and a local NGO.

In order to steer the project into the desired direction, Fred had to reverse the power relationship between the project developer and the architect. Normally the architect takes the lead as soon as soon as the program of requirements is finalized by the project developer. In this project, however, architects are mere advisors creating space for a quite unusual combination of new technologies and financing schemes.

The success of the project is not yet secured, but certainly a lot has been learned among the many stakeholders in the process. The diffusion of this learning and of the concept as a whole into wider society, and the reversal of power relationships, will be investigated during the project and after the project is finished. Similarly, the question if and how this building fits into a vision of Sustainable Boston, and how it may catalyze this process or be catalyzed by it, needs further research.

(Vergragt and Brown, work in progress (2004))

Summarizing, In the Boston Metropolitan Area a visioning process is under way that incorporates the visions and aspirations of many local stakeholders. However, global sustainability and equity are not yet part of the framework for this visioning, which may lead to long-term unsustainable solutions. Tellus Institute brings elements of global sustainability and equity into this visioning process, which leads to learning processes among stakeholders. In addition, it is necessary that parallel to this visioning processes, ongoing and new socio-technical experiments should be fostered, to generate and diffuse social learning among the stakeholders, and to advance implementation of elements of the sustainability vision.

5. Towards an integrated policy framework

In this paper we have argued that visioning, backcasting, and bounded socio-technical experiments are necessary for transitions towards sustainable cities, mainly by fostering social learning processes among heterogeneous stakeholders, such as business, government, and NGOs. These propositions are tentative, based on our theoretical research and on limited empirical verification. They have implications for the development of integrated sustainability policies.

Next to regulatory and economic policies, and policies aimed at negotiated agreements, these policies should first of all be aimed at the development of a challenging and attractive sustainability vision by the regional or local government. Such a sustainability vision should be endorsed by a broad stakeholder constituency, laying out the challenges ahead. It is not a simple exercise, because it may imply hard and difficult decisions, and deep changes in lifestyles and values that are not easily accomplished. The vision should be developed with great care, as a combination of a bottom-up visioning process with local stakeholders as in de Boston MetroFuture case, in combination with the development of diverging scenarios by experts. Creativity sessions and backcasting exercises together with local stakeholders should be part of this process. The orchestration of this process should be a combination of top-down planning and bottom-up initiatives, which requires very careful managing.

The second element of this integrated policy framework should be the fostering and nurturing of socio-technical experiments. For these, the primary aim would not so much be the implementation of new technologies, services, and systems in society, but higher order learning among stakeholders about sustainability, about other stakeholders' preferences, about consumers' acceptance, and about barriers to system innovation and transition. A good example of this is the hydrogen fuel cell buses in the EU CUTE project, which are financed for a limited period (three years) and which will not be immediately adopted afterwards.

The third element would be fostering a mechanism for diffusion of learning from these types of experiments. This could for instance be a good monitoring system of learning effects. Or it could be a system of connecting various BSTEs with each other, making connections between heterogeneous experiments and actors, creating effective communication channels for exchanging information and diffusing learning. We have yet limited theoretical insight in the mechanism of diffusion of higher order learning in society, so these policies will have to proceed through trial and error, which in itself may induce a lot of learning.

The fourth element would be backcasting and implementation. Backcasting is translating back from a sustainable future vision into the present, and identify steps to be taken. It should be combined with upscaling and diffusion from successful BSTEs into wider society. Policies could foster that through information and communication services, education, and fostering learning in all its aspects. In combination with this, more traditional policies like regulation and economic incentives need to be deployed for successful implementation.

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