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Backcasting for Industrial Transformations and System Innovations Towards Sustainability: Relevance for Governance?

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1. Introduction

Radical changes to present production and consumption systems, especially in the developed world, are required to achieve sustainable development. Those changes on a system level are often described as industrial transformations, while terms like system innovations or transitions towards sustainability are also being used. These system changes or transformations require combinations of technological, cultural, social, institutional and organisational changes, while they affect many stakeholders when diffusing into society, and involve complex processes of social change on the long term. Questions have been raised so far about how to identify attractive and desirable system changes (system innovations, industrial transformations or transitions), how to explore these, how to get them started and implemented in practice, about the role of different stakeholder groups and stakeholder co-operation and how do they relate to the issue of governance. According to Quist et al (2002) bringing about system innovations requires *new integrated approaches* that should at least combine:

- The involvement of a broad range of stakeholders and actors from different societal groups including government, companies, public interest groups and knowledge bodies, not only when defining the problem but also when searching for solutions and conditions and developing shared visions.
- Incorporating not only the environmental component of sustainability, but also its economic and social component.
- Taking into account the demand side, consumption and the supply chain focussing on related production and consumption systems

Though these characteristics imply guidelines that give at least some direction, but they definitely do not give the full answer to the questions raised above. Yet backcasting might be an interesting candidate as an approach that meets the characteristics mentioned above and could be used for dealing with the questions mentioned. Backcasting has been proposed and tested in the Netherlands as a promising participatory planning approach to identify and explore such innovations towards sustainability (on a system level), while also aiming at follow-up and implementation in public research, companies, public interest groups and the government. 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, before defining and planning follow-up activities and developing strategies leading towards that desirable future. While quite some results of participatory backcasting have been reported so far, rather little has been done on comparing different backcasting experiments, on conceptual issues, on the relevance for governance, and how it relates to other recently emerging approaches like transition management and strategic niche management.

This chapter aims to explore how backcasting relates to the issues and questions raised above. It provides an overview of the developments and varieties in backcasting that occurred during several decades. It elaborates how backcasting can be seen as an integrated approach for bringing about sustainability on a system level and describes its key characteristics including the issue of involving stakeholders. It also describes and compares two backcasting experiments and discusses the relationship with other emerging system oriented participatory approaches in sustainability studies. This chapter is structured as follows. Section 2 gives a brief history of backcasting starting with its origin in the 1970s in energy studies and its further elaboration and application for sustainability issues especially in Sweden and the Netherlands. It concludes that participatory backcasting is the most recent and emerging variety. Next, section 3 elaborates upon methodological and theoretical aspects of participatory backcasting. It proposes a general scheme based on different varieties of backcasting developed and tested before. It also deals briefly with some key mechanisms and elements underpinning participatory backcasting. Section 4 and Section 5 present and analyse two participatory backcasting cases from the Netherlands in the area of food production and consumption. Those are derived from the governmental Sustainable Technology Development (STD) Programme and the international spin-off research project 'Strategies towards the Sustainable Household (SusHouse) and deal with how backcasting has been applied and what kind of follow-up and implementation results have been achieved (so far). Finally, section 6 contains conclusions and discussion with respect to backcasting and its broader relevance, while also attention is paid how the approach relates to other approaches like transition management and strategic management and to the relevance for governance.

2. Back-casting: a brief history

This section explores the existing literature analysing different conceptualisations and practices of backcasting, from its early emergence in the 1970s till now, and focusing on sustainability applications. In fact, there seems to be more or less a family of related approaches all using desirable futures or normative scenarios. Interestingly, the history of backcasting goes back to the same origin as the strategic and multiple scenario approaches, which were so advantageous to Shell during the first oil crisis in the early 1970s.

2.1. Backcasting in Energy studies: soft energy paths

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[1] (Robinson 1982, Anderson 2001). According to Robinson (1982) Lovins mentioned the method originally 'backwards-looking analysis', while Robinson introduced the term Energy backcasting. Assuming that future demand is mainly a function of current policy decisions, Lovins originally suggested that it would be beneficial to describe a desirable future (or a range of futures) and to assess how such a future could be achieved instead of focussing on likely futures alone. After having identified the strategic objective in a particular future, it would be possible to work backwards to determine what policy measures should be implemented to guide the energy industry in its transformation towards the future required energy industry.

This type of backcasting studies was especially concerned with so called soft energy (policy) paths, taking as a starting point a low energy demand society that relies on renewable energy technologies. The focus was on analysis and on achieving policy goals, while the 'backcasts' of different alternative energy futures were also meant to reveal the relative implications of different policy goals (Robinson 1982: 337-338), and to determine the freedom of action for policy making. From the beginning, it was strongly emphasised that the purpose of backcasting was not to produce blueprints, but to compare relative feasibility and implications of different energy futures (including social, environmental and political implications) under the assumption of a clear relationship between goal setting and policy planning.

Robinson (1982) also elaborated the principles set by Lovins into a sequential six-step methodology for energy and electricity futures. The central step was to develop an outline of the future economy through the construction of a model of the economy in a final future state followed by developing an energy demand scenario corresponding to the results of the model. Recently, Anderson (2001: 612) has commented that the proposed future step in the original approach applied by Lovins and Robinson included a model that was dependent on long-term economic predictions. Anderson (2001) has therefore suggested an alternative model in which both supply and demand are treated as endogenous factors in the process of policy making. He has adapted the energy backcasting approach aiming to reconcile the electricity industry with sustainable development. The adapted approach assumes wider environmental and social responsibilities, a broadening of necessary knowledge (from a range of disciplines and including so-called non-expert knowledge) and a more flexible and responsible policy agenda.

However, both Robinson and Anderson emphasise the potential of backcasting for policy analysis and policy development, but especially from a governmental perspective. They refer to policy analysis in the traditional sense of supporting policy and policymakers with information on different future options and 'to indicate the relative feasibility and implications of different policy goals' (Robinson 1990: 823). Furthermore, the early focus in backcasting was not yet on the wider applicability for dealing with sustainability issues, but on exploring and assessing energy futures.

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[1] The original publications of Amory Lovins are referred to by Robinson (1982). It includes Lovins' paper entitled 'Energy strategy: the road not taken?', which was published in Foreign Affairs in October 1976 and his book entitled 'Soft Energy Paths', published by FOE/Ballinger in 1977. Additionally, Robinson (1982) contains a comprehensive list of the soft energy path backcasting studies, which were especially carried out in Canada.

2.2. Backcasting for sustainability in Sweden

Those who applied backcasting must have realized that it had a much wider potential for application, due to its normative nature. For instance, Robinson (1988) dealt with wider conceptual and methodological issues, including the role of learning (and unlearning) about the future, the issue of broadening the process to a larger group of potential users, and to alter the hegemony of existing theoretical perspectives. Elsewhere, Robinson (1990: 822) mentioned that backcasting is not only about how desirable futures can be attained, but that it can also be used to analyse the degree to which undesirable futures can be avoided or responded to. However, the focus is on desirable futures, and backcasting is described as an explicitly normative approach involving working backwards from a particular desirable future endpoint to the present, in order to determine the physical feasibility of that future and what policy measures would be required to reach that point.

Robinson's (1990) paper marked the move towards sustainability applications of backcasting. It also links to the origin of the backcasting practice in Sweden as the paper reports on a study funded by the Swedish Energy Research Commission. This was followed by substantial efforts in practical backcasting and conceptual thinking (e.g. Dreborg 1996, Holmberg 1998, Bannister et al 2000, Hojer and Mattsson 2000). For instance, Dreborg (1996) mentions that traditional forecasting is based on dominant trends and is therefore unlikely to generate solutions based on trend-breaches. He argues that backcasting approaches due to their problem-solving character are much better suited for long-term problems and long-term sustainability solutions, while it is more useful to consider backcasting as an approach within in a range methods can be applied, than as a specific method (1996: 818). According to Dreborg backcasting studies should aim at providing images of the future as a background for opinion forming and decision making to policy makers and the interested general public. Interestingly, Dreborg emphasises that our perception of what is possible or reasonable may be a major obstacle to real change, which refers to earlier remarks (Robinson 1988) about (un)learning and the dominance of existing perspectives. The scenarios of a backcasting project should therefore broaden the scope of solutions to be considered by describing new options and different futures. Dreborg (1996: 816) also argues when backcasting is especially promising. This is in case of: (1) complex problems, (2) when there is a need for a major change, (3) when dominant trends are part of the problem, (4) when externalities cannot be solved by a market approach (in a satisfying way), and (5) when there is a need for long time horizons. Sustainability problems are then clear examples of such problems (Dreborg 1996).

Interestingly, Dreborg also focuses on the conceptual level beyond the stepwise method of Robinson, and relates backcasting to the field of Constructive Technology Assessment. This enables to distinguish between the practical and analytical side and the constructive process-oriented side. Concerning the practical and analytical side the main product of backcasting studies are alternative images of the future, thoroughly analysed as to their feasibility and consequences. Concerning the process and constructive oriented side, backcasting studies should be addressed, according to Dreborg (1996), to many actors including political parties, governmental authorities, municipalities, organisations, enterprises and an informed general public. In addition, the studies are also meant for providing input to a policy developing process in which these actors should also be involved. Dreborg also argues that it is essential that backcasting studies provide alternative images of the future that are assessed on their consequences in a credible way, while the results are not meant to form a basis for a single big decision nor as a detailed plan or a blueprint.

Also working within the Swedish backcasting community, Hojer and Mattsson (2000) suggest that backcasting and different forecasting approaches are complementary, favouring backcasting especially in cases where current trends are leading to-

wards an unfavourable state. They include a step in which forecasts and a desired vision is compared with each other. If the vision cannot be reached according to the most reliable forecasts, model calculations, and other estimates, the task of the backcasting study should be to generate images of the future or scenarios that fulfil the targets expressed in the vision. The images must be scrutinised to examine potential effects. Furthermore, in addition to the normative scenario-forming side of backcasting, Hojer and Mattsson (2000: 630) also emphasise what they call the analytical and critical side of backcasting, by asking themselves how is it possibly to attain a state that has been identified as desirable? They mean here that it is not only important to develop the normative future vision solving certain problems, but that it is as important to work back from that desirable future to check the physical and social feasibility of the route towards that future, and the necessary measures and actions for bringing about that future. Furthermore, Hojer and Mattsson (2000) emphasise that the use of models and tools helping to quantify the consequences of different measures is as important as constructing the future visions. With respect to the consequences, regular forecasting tools can be necessary, while tools from the field of impact assessment and technology assessment can contribute too.

In Sweden backcasting has also been elaborated as a methodology for strategic planning for sustainability (Holmberg 1998), which has become known as the Natural Step methodology and has been advocated and popularised by Robert. Though Robert considers it more as 'backcasting from principles', rather than as 'backcasting from scenarios', it could be said that satisfying the principles takes place in a future state. This variety of backcasting has been applied quite successfully in corporations like Ikea, the carpet producer Interface and Scandic hotels (Holmberg 1998, for a detailed account see Nattrass and Altomare, 1999). It starts with support by the CEO or owner and includes broad participation of as many employees as possible. It also includes consultation of all levels for generating ideas how to become a sustainable corporation. It goes beyond good housekeeping and regular environmental management and aims at making the business itself sustainable over the full production chain. This example shows that it is possible to apply backcasting both on a system or societal level and on the level of particular organisations.

2.3. Backcasting in the Netherlands

Since the 1990s backcasting has also been applied in the Netherlands, first at the governmental programme for Sustainable Technology Development (STD) that ran from 1993 up to 2001, and in its EU funded spin-off, the research project 'Strategies towards the Sustainable Household (SusHouse) that ran from 1998 to 2000. Both initiatives focused on achieving sustainable need fulfilment in the far future using a backcasting approach that included broad stakeholder participation, future visions or normative scenarios, and the use of creativity for getting beyond present mind sets, paradigms and actor reference frameworks. Vergragt and Jansen (1993), inspired by the Swedish example, mentioned backcasting as part of the philosophy of the STD programme. They described the basic idea (1993: 136) 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.* Furthermore, Vergragt and Jansen emphasised – like Dreborg (1996) in Sweden – the link with Constructive Technology Assessment concepts and approaches referring to the broadening of technology development processes with sustainability aspects and the participation of social actors like public interest groups in addition to the traditional participants in such processes. Elsewhere, Vergragt and Van der Wel (1998: 173) go beyond the desirable future – like Hojer and Mattsson (2000) also did – and emphasise 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 characterised as interactive (many stakeholders are involved) and iterative (feedback is continuous between future visions and present actions). Elsewhere, Weaver et al (2001: 74) reporting on approach and results of the STD programme. They describe backcasting as a possible tool for establishing shared visions of desirable future system states, while securing a 'systems' perspective on the transition process and of help in defining feasible short-term actions that can lead to trend-breaking change. Interestingly, Weaver et al (2002: 72-78) refer to backcasting as a tool, as a full methodology, as a concept, as an operational approach and also as a specific step in the full methodology. This seems to reveal the need for clear definitions and distinctions.

The aim of the SusHouse project was to develop and test strategies for sustainable households in the future. The researchers referred in general to the SusHouse approach, but in fact it was a backcasting approach that used stakeholder workshops, creativity methods, normative scenarios, scenario assessments and backcasting analysis (Vergragt 2000, Quist et al 2001, Green and Vergragt 2002). Contrary to the STD programme, the emphasis was less on the technology and more on achieving cultural and lifestyle changes contributing to sustainability. Though it was originally planned that all backcasting activities could be concentrated in a single workshop, it appeared that these took place throughout the whole project, not only during the stakeholder workshops, but also during the scenario elaboration and scenario analysis activities by the research teams (Quist et al 2000). Furthermore, Quist et al (2000: 8-16) also mention the link with CTA, social shaping theories of technology development (from which CTA originally was derived). Furthermore they mention the connections with the field of Creative Problem Solving (e.g. Isaksen 2000), the importance of defining steps contributing to developing such a sustainable desirable and the importance of (conceptual) learning by stakeholders and involved researchers facilitating the process.

Taking a more reflexive perspective and looking back to the participatory backcasting experiments in the Netherlands, Vergragt (2001: 11) emphasises that future visions that are shared among stakeholders are a necessary but not sufficient condition for achieving implementation and follow-up. It is also important to understand the culture and interests of stakeholders, their motives for both participation in the backcasting study and for the desired follow-up after the backcasting study has been completed.

Backcasting has become a popular approach in the Netherlands. It has been applied rather widely and influenced the Dutch strategies for sustainability considerably (AWT 1998) and long-term strategic thinking in the Netherlands in general. For instance, backcasting and normative future visions have been applied in strategic reorientation of the research programmes at DLO, the major Dutch research organisation for agriculture and rural development (Grin 2003). Partidario has elaborated and applied an approach rather similar to the SusHouse approach for studying future prospects for sustainability in paint chains in the Netherlands and Portugal (Partidario 2002). Van de Kerkhof et al (2003) have developed a backcasting approach focussing on the diversity in views, visions and interests among stakeholders involved in a debate on different futures meeting Kyoto targets with respect to reducing greenhouse gas emissions. Geurs and Van Wee (2000) have applied backcasting as a tool to develop sustainable transport scenarios. Rotmans et al (2001) working on transition management also refer to backcasting from the future within their approach. Finally, Jansen (2003) pays attention to backcasting in national foresighting programmes and compares these to the Dutch practice in backcasting at the STD programme.

2.4. Conclusions so far

Backcasting originates from the 1970s and was originally developed as an alternative for traditional forecasting and planning. It was originally considered as an additional policy analysis tool for energy planning, using normative or sometimes also possible scenarios emphasising its analytical nature, while later on since the 1990s the emphasis shifted towards its potential for identifying and exploring sustainability solutions, towards broad stakeholder participation, and to multi-actor interaction processes, towards enhanced normativity of scenarios based on strong visions shared and supported by stakeholders, and to the importance of conceptual learning. So, participatory backcasting is the most recent variety and an emerging approach. Interestingly, the shift to participatory backcasting has, quite independent from the developments in the Netherlands, taken place in Canada (Robinson 2003) and more recently, also in Belgium (Keune & Goorden 2002) and in Sweden (Carlsson-Kanyama et al 2003).

Furthermore, it can be concluded from the literature review that backcasting can refer to a concept or philosophy, a study, an approach, a methodology, an interaction process among participating stakeholders, an assessment/analysis (sometimes referred to as a backcast) or the specific step of looking back from the desired future within an overall stepwise (but iterative) approach or methodology. This implies also that backcasting can be dealt with on the conceptual or holistic level, the level of social or multi-actor processes, the level of overall approaches and methodologies containing multiple steps, methods and instruments, and on the level of specific steps, methods or instruments within such an overall approach or overall methodology. This implies that backcasting is more than looking back from a desirable future, and when using the term backcasting reference should be made to the level and the activity.

3. Methodological and theoretical aspects of participatory backcasting

This section starts dealing with methodological aspects, before proposing an elaboration of five stages, and ends mentioning some key mechanisms and concepts underpinning participatory backcasting.

3.1. Activities, toolkit and possible goals for participatory backcasting

Though backcasting has not always been applied as a participatory approach, stakeholder involvement is strongly emphasised in recent backcasting experiments for sustainability (Weaver et al 2000, Quist et al 2001, Green & Vergragt 2002, Robinson 2003, Van de Kerkhof et al 2003). Therefore, in this section is focussed on the methodological aspects and characteristics of participatory backcasting.

From a methodological viewpoint, it is possible to distinguish four major activities that are necessary within a participatory backcasting framework. These are:

- Orientation (on the problem);
- Design (of the future vision or normative scenario and of the process)
- Assessment and analysis
- Participation of stakeholders

This implies that backcasting uses very different methods and tools that relate quite strongly to the major activities distinguished above. So, backcasting requires tools and methods for *stakeholder participation*, for *design and development* of future vision, for the process, and for analyses and assessments. In addition to the participatory tools, tools and methods for process and stakeholder management are an important category too. It is necessary to make this distinction, as these are different from participatory

tools focussing on interaction and involvement. Furthermore, there is not a specific group of tools connected to the *orientation*, but here tools and methods can be used from each category of tools and methods distinguished below. Furthermore, the orientation should include setting normative assumptions and goals. So, four categories of tools and methods can be distinguished in a participatory backcasting framework:

- *Participatory tools and methods*. This category concerns all tools and methods that are useful for involving stakeholders and generating and guiding interactivity among stakeholders. It includes specific workshop tools, tools for stakeholder creativity and tools helping stakeholders in specific backcasting activities and tools for participatory vision and scenario construction. Mayer (1997) has given an interesting overview of participatory tools and methods.
- *Design tools*. This category includes not only scenario construction, but also elaboration and detailing systems and process design tools. De Bruijn et al (2002) dealt with process design methodologies, while design methods for scenarios and for defining and elaborating (socio-technical) systems are widely available.
- *Analytical tools and methods*. Those relate not only to assessment of scenarios and designs, for instance consumer acceptance studies, environmental assessments, economic analysis, but include also methods for process analysis and evaluation, stakeholder identification and stakeholder analysis.
- *Overall process management and stakeholder management tools and methods.* Apart from specific participatory methods, there are methods that are relevant for the overall approach and the overall process, but which are more specific than the overall backcasting approach. It includes methods, which can be applied for shaping and maintaining stakeholder networks that originate from the backcasting study. Some mention this process management (e.g. De Bruijn et al 1998), while there are also methods in Constructive Technology Assessment (Van den Ende et al 1998).

In the literature on energy backcasting, there is a considerable goal orientation. However, this relates to goals connected to the desirable future states. Here, backcasting is considered as an approach applied in a study of limited time, which can be several months to several years. Possible goals for backcasting studies include:

- Generation of normative options for the future and putting these on the agenda of relevant arena's;
- Future visions or normative scenarios;
- A follow-up agenda containing activities for different groups of stakeholders contributing to bringing about the desirable future;
- Stakeholder learning with respect to the options, the consequences and the opinions of others.

It is important to realise that the main activities, the groups of tools and the different goals identified here, imply the usage of different types of knowledge and skills not only from different stakeholder groups but also from different disciplines and different professional groups and that it requires interaction between different stakeholder and professional groups. This means that it is not only multi-disciplinary, but also trans-disciplinary. This implies not only clear knowledge demands, but equally important – and even more difficult to be met - clear process demands and process management.

3.2. A five-stage approach for backcasting

Though most approaches found in the literature show differences in methods applied, ways of stakeholder involvement and number of steps (Robinson 1990, Holm-

berg 1998, Weaver et al 2000, Quist et al 2001), it is possible to generalise and translate the approaches identified in the literature into a general description for participatory backcasting consisting of five stages (or steps). The five main stages, as distinguished here, are:

- Strategic Problem Orientation
- Construction of sustainable future visions or scenarios
- Backcasting stage
- Elaboration, analysis and defining follow-up activities and action agenda
- Embedding of action agenda, activities and generating follow-up *and* implementation

It is necessary to address a few points here. First, it is assumed that setting the normative assumptions and goals are part of the first stage, as is achieving agreement on the normative assumptions among stakeholders involved. However, sometimes these are set before the problem orientation starts or have already been set within an overall frame. This was for instance the case in the Netherlands at the STD programme, where the time horizon of 40 years, the factor 20 and the focus on sustainable need fulfilment were set as general assumptions, and were approved by key persons of participating ministries and some leading industries in the Netherlands before specific backcasting studies were initiated.

Second, if there are more than five steps distinguished in a backcasting approach, it is in general possible to see specific steps as part of the suggested five stages. Next, it has been suggested (e.g. Holmberg 1998) that the fourth and the fifth stage could be combined into one. Furthermore, it may also be argued that because it is so difficult to finish the fifth step in particular projects, the end of the backcasting study should be positioned early in the fifth stage, leaving out implementation and the generation of follow-up – like was done in the SusHouse project (Quist et al 2001). However, as embedding and initiating follow-up and implementation are so crucially important, it is argued here that is justified to distinguish it as a separate stage in the approach.

Fourth, it must be mentioned that though the approach is depicted stepwise and linear, it definitely is not. Iteration cycles are possible, while there is also a mutual influence between two steps following one to another. Although it might be interesting to conceptualise it as a set of activities that all need to be done, instead of in a linear sense, in practical applications it remains necessary to combine it with a transparent time frame that can be communicated with stakeholders involved. So, due to the time and process constraints, it has to be depicted as linear in time. Five, the backcasting process has a dynamic nature, which means that stakeholders might leave the process, while new stakeholders might join it.

In addition, each stage of the backcasting approach requires in general tools and methods from all four categories distinguished; though it may be different tools and methods in particular stages. Finally, four major societal groups can be distinguished: companies, research bodies, government and related bodies and last but definitely not least public interest groups and the public. Of course, identifying appropriate organisations and relevant individuals within these organisations, also reflecting all stages of the supply chain and the related consumption system is to be done within specific backcasting studies.

3.3. Brief elaboration of the stages in participatory backcasting

Five stages can be distinguished in participatory backcasting. This subsection deals with each stage and pays also attention to the variety that can be found in a specific stage.

Stage 1: Strategic Problem Orientation

This stage includes - if this has not been done yet - setting normative assumptions and targets, which can also be done through stakeholder participation. This stage aims at exploring the problem from a systemic viewpoint, possible problem definitions, main unsustainabilities, opportunities, and possible solutions, identifying and involving relevant stakeholders. In addition, it should be analysed how the problem is perceived by different stakeholders, how it relates to need and function fulfilment on an appropriate level – which is often a societal level or the level of socio-technical systems (Quist 2003), how other stakeholders evaluate and judge the different problem formulations according to their own mind set, values and interests, and how supply chain and demand side are interdependent and influence each other. It is important to take an integral viewpoint, while taking into account related consumption and production systems and present trends and developments for the whole system. Involving stakeholders is also important because they are experts in the field or system under study (of a part from it). The table below provides a preliminary checklist that can be applied.

Table 1: A preliminary Checklist for a Strategic Problem Orientation Stage

What is the problem (at stake)? Who is (are) the problem-owner(s)
What are major trends and developments?
Who are stakeholders and future stakeholders? What are their problem definitions and problem perceptions? What are their interests, relations and resources?
What kind of possible solutions or solution directions do stakeholders see? How do other stakeholders perceive these? Who might have an interest concerning this solution? Who does not?

Stage 2: Construction of sustainable future visions or scenarios

The results of the Strategic Problem Orientation stage are the starting point for construction of sustainable future visions or scenarios in which the identified unsustainabilities and problems have been solved. Stakeholder participation is important here, so workshops are an important tool in this stage, though different types of workshops and other participatory methods are also possible. The relevant question is how this societal need or function can be fulfilled in a sustainable way in the far future, assuming that it is always possible to define a societal need or function in a particular backcasting study.

Furthermore, different types of future visions are possible. For instance, within the STD programme a generic sustainable future vision was generated that contained several solutions for different major unsustainabilities, while in the SusHouse project several sustainable and more detailed scenarios were generated that depicted different sustainable lifestyles that could be seen as each other's substitutes. In addition, SusHouse scenarios did not only contain a vision and a description of main characteristics, but were elaborated with storyboards depicting daily life stories within a specific scenario, proposals for product-service systems supporting the sustainable scenario, and sometimes with images. It seems that generating single visions or several scenarios have each specific advantages and drawbacks, but a systematic evaluation of this has not been done yet. Furthermore, quite a number of specific methods are available for constructing future visions and normative scenarios. Scenarios or future visions can either stress the vision part, the feasibility, or the creative part. It is also possible

to add first estimates or preliminary assessments for particular aspects like environmental improvement potential, consumer acceptance, socio-economic aspects, etc.

Stage 3: Backcasting – setting out sustainable alternatives

Though the overall approach is named after this stage, it is actually the stage that is least elaborated and described in the backcasting literature. Aarts (2000: 36-40) refers to realising the gap between a sustainable future and the present situation, and to look backwards seeking for ideas, leapfrog technologies and trend breaches. She mentions as methods elaboration of future visions, writing essays, explorative research, expert workshops and stakeholder workshops. Quist et al (2000) try to guide the backcasting stage with a specific guiding question 'What are the necessary changes to realise this future vision or scenario'. So, different varieties can be distinguished in this stage:

- A quick one just meant for identifying attractive solutions or clusters that would enable radically increased eco-efficiency. This was, for instance, done at the STD programme (Weaver et al 2000).
- A more elaborated variety, asking for the changes necessary for achieving a specific future vision or sustainable normative scenario, which was applied in the SusHouse project (Quist et al 2000). This meta-question can be split into specific questions for which technological changes are necessary, which cultural and behavioural changes are necessary, which structural-institutional changes are necessary and which organisational changes are necessary for realising the desirable sustainable future state.
- A very detailed one defining and describing also in-between states. For instance, if the final state is set in 2040, reasoning back from 2040 the state of 2030 can be described, before describing the state of 2020 and 2010. Though this variety is commonly used for explaining backcasting, it has hardly been applied in professional practice.

Stage 4: Elaboration and defining follow-up activities and agendas

Elaboration can take many forms and depends strongly on capacity, budget and time available. Assessments, analyses and feasibility studies are important in the first part of this stage, while defining follow up activities and agendas that enable implementation and realisation on the longer term are important in the second part of this stage. Differences can be noticed too. For instance, in the SusHouse project, it were the normative scenarios that were elaborated and assessed by small research teams dealing with two case studies and for each case study several scenarios. At the STD programme, backcasting was used to identify promising clusters and directions within a single future vision, and those clusters were subjected to feasibility study and further elaboration in particular projects. This enabled to involve more specialised researchers, while stakeholders involvement was more focussed too.

Stage 5: Embedding of action agenda and generating follow-up

As the aim of backcasting for sustainable strategies is to bring about change processes, system innovations or transitions towards sustainability, it is important that the outcomes of the backcasting study are embedded and taken further by stakeholders of groups of stakeholders. It has already been mentioned that each societal group has to deliver its contribution, while it cannot be blueprinted due to the complex nature of social change and social learning processes. Nevertheless, the future vision can act as a guiding image or leitmotiv, while R&D and action agenda contain a bundle of possible roads and suggestions that must be elaborated by appropriate stakeholders.

3.4. Theoretical aspects of participatory backcasting

This subsection briefly deals with some theoretical aspects and key mechanisms underpinning the approach of participatory backcasting. But before that, we want to stress here that backcasting is inherently of a normative nature – sustainability is a normative concept -, while this is combined with the recognition that our society is socially shaped. This means that the results of backcasting approaches stem from processes of social interaction involving various social actors and taking into account the plural character of present societies.

Future visions

It has been shown that visions are important in technology development as guiding images that are endorsed by actors. This has led in Germany to a body of literature on *leitbilder* (in analogy with *leitmotiv*) in technology studies. For instance, Grin and Grunwald (2000: 1) assume *that one way to shape socio-technological systems is through the visions that guide their development… the assumption is that these visions exist already in most societal sectors, that these visions tend to reproduce the ways in which these sectors have developed hitherto, and that a critical discussion of these visions is a prerequisite for changing the course of development.* In addition, they ask .. [I*]s it possible to provide some orientation to long-term development in a way that it may contributes to meeting challenges like the need for sustainability, while ensuring public legitimacy and avoiding the risk of authoritarian blueprints.* Their preliminary answer is in fact positive. They distinguish two main features of visions (Grin and Grunwald 2000: 11). First, mental images of attainable futures shaped by a collection of actors. Second, it guides the actions of and the interactions between these actors (see also Quist et al 2001). Furthermore, these visions can be used for broadening the debate on changing socio-technical systems, and it could lead to conceptual learning and adjustments in technological designs and design processes resulting in an improved alignment of technology and society. In addition, visions may have the potential for dealing with problems for which there are no rules or institutions available (Grin 2003, Quist 2003). Sustainability problems are clear examples.

Stakeholder learning

Another important element is higher order or conceptual actor learning. Social interaction between actors and negotiations can lead to learning processes not only on the cognitive level but also with respect to values, attitudes and underlying convictions. The latter is also known as higher order learning for which several conceptualisations have been made (for a discussion on this, Brown et al 2003). In policy oriented learning, for instance, it involves redefining policy goals and adjusting problem definition and strategies, while in organisational learning it involves changes in norms, values, goals and operating procedures governing the decision-making process and actions of organisations. This is of great importance in case of complex problems with opposing actors having a different mental framework or action theory (Grin et al 1997). The approach of action theories is of interest here as it links the mental framework with the space for behavioural alternatives. The assumption here is that higher order learning leads to changes in the mind set or reference framework and thereby broadens the space for actions and behavioural alternatives.

Process aspects

Next, process aspects and dynamics are not only relevant for explaining the outcomes immediately after a backcasting experiment, but include relevant factors enabling and constraining the realisation follow-up and implementation supporting the direction of the defined (desirable) transformation of the socio-technical system (Quist 2003). Backcasting experiments around normative future visions are in fact complex processes and involve numerous actors having different reference frameworks, value

sets and interests. So, tactic and strategic behaviour can take place, there are power issues and dependencies at stake, while it also concerns negotiation on problem definitions, normative goal setting, creating a sense of urgency on the short term, etc. Therefore, process management is also relevant here (e.g. De Bruijn et al 2002).

4. Case I: STD programme: Novel Protein Foods

4.1. Background of the STD programme

After the history, the methodological aspects, and some theoretical issues, we present here two cases in which participatory backcasting was applied. Early in the 1990s the governmental programme for Sustainable Technological Development (STD) was initiated in the Netherlands aiming not only at exploring system innovations towards sustainability, but also to explore opportunities and possibilities for developing sustainable technologies. This was then not as straightforward as it is nowadays in many developed countries. At that time the focus of policy makers, technology developers and corporations was mainly on clean technologies and end-op-pipe solutions, while there was still a strong debate, if technology was the major cause of environmental problems or if technology could also be part of a solution. The STD programme ran from 1993 until 2001. Taking the factor 20 increase in environmental efficiency of need fulfilment as a challenge for technology development at the STD-programme, and applying an interactive and stakeholder-oriented backcasting approach, a number of societal needs like nutrition, water, mobility and housing were explored focusing on future sustainable alternatives for fulfilling these societal needs.

This was done by developing future visions for the sustainable fulfilment of these needs using the expertise of stakeholders from government, companies, research bodies and public interest groups (STD 1997, Weaver et al 2000). These future visions were analysed as alternative solutions having the potential to meet the factor challenge, which were elaborated in projects. Examples of factor 20 projects at the STD programme included the mobile hydrogen fuel cell (Vergragt and Van Noort 1996, Weaver et al. 2000), Urban Underground Freight Transport (STD 1997), Novel Protein Foods (Quist et al 1996; Weaver et al 2000), Sustainable Multiple Land Use in which function integration and reduction environmental burden in rural areas were combined (STD 1997), Sustainable Urban Renewal in the city of Rotterdam, C1-chemistry based on biomass (Weaver et al 2000) Sustainable Municipal Water Systems (Weaver et al 2000). For an overview of all projects and results, see STD (1997), while Weaver et al (2000) give a more detailed analysis of 7 projects.

The projects at the STD programmes included not only radical technological innovations that met the factor challenge but also the identification of cultural and structural conditions for development and implementation. Projects could also be described as complex multi-actor processes around a socio-technological solution aiming at a factor 20 reductions in environmental burden in fulfilling societal needs in the future. Objectives of these projects included future visions or designs, research programmes for developing the fundamental scientific knowledge required for realising the identified sustainable technology, networks around the identified technology, development paths or trajectories, sight on short term spin-off and embedded follow-up activities by stakeholders.

In general, the STD programme was considered to be very successful in identifying alternative solutions having the potential for achieving considerable environmental reduction factors, and in developing follow-up agendas and strategic research programmes, though the programme did not succeed in all projects to establish follow-up. Furthermore, during the STD programme it appeared that quite a number of

sustainable technologies are available (or 'on the shelf'), but that present cultural and structural conditions restrict further development and implementation (Aarts 1997).

4.2. Approach at the STD programme

A participatory backcasting approach was applied at the STD programme, but how was it applied? Following the description of Weaver et al (2000: 76), it was an approach of 7 steps as depicted in Figure 1. According to Weaver et al (2000: 76), Step 1-3 are meant for developing ave solutions for sustainable need fulfilment. Step 4 and step 5 were meant to clarify the short-term actions that are needed to realise that future which can be seen as a joint action, R&D and policy agenda. Step 6 and step 7 focused on implementation and realising the action agenda and plan. This was meant to be done by stakeholders involved in the backcasting process by setting up co-operations enabling implementation o long-term vision based on a strategic review of how a need might be met in the future in a sustainable way and using backwards analysis to set out alternatif a research agenda. The STD programme facilitated this as far as possible.

Figure 1: The STD methodology (Weaver et al 2000, Vergragt 2001)

Develop long term vision	Develop short term actions	Implementation
1 Strategic problem orientation and definition 2. Develop Future Vision 3. Back-casting	4. Explore solution options 5. Select among options: set up action plan	6. Set up cooperation agreement-define roles 7. Implement research agenda

The 7-step approach applied at the STD programme agrees well with the approach of five stages described earlier, as Table 3 also shows. Steps 1-3 of the STD approach are similar to the stages 1-3 as proposed in this chapter. In addition, step 4 and step 5 of the STD approach matches with stage 4 in this chapter, while step 6 and step 7 are similar with stage 5. So, in comparison with the general description, at the STD programme both stage 4 and stage 5 were split into two steps.

Table 3: Comparison of the backcasting approach proposed and the STD approach

Backcasting approach	STD approach
1. Strategic problem orientation	Step 1
2. Construction of desirable (normative) scenario or future vision	Step 2
3. Backcasting stage	Step 3
4. Elaboration (design *and* analysis) and defining follow-up activities and action agenda	Step 4, step 5,
5 Embedding of action agenda, activities and generating follow-up *and* implementation	Step 6, Step 7

The approach at the STD programme was applied in an iterative way, while sometimes parts of the visioning were redone later in the process, for instance to involve newly entered stakeholders. This can be illustrated for the exploration of nutrition. The construction of a sustainable future for the need of nutrition led to the identification of several alternative solutions like multiple sustainable land-use and novel protein foods as an alternative for present meat consumption and production. The next step – step 4 in the description of Weaver et al and stage 4 as proposed here – would be to explore this solution further. This is shown below when dealing with the example of Novel Protein Foods.

4.3. Novel Protein Foods case: outline and results

Novel Protein Foods emerged from the participatory stakeholder analysis for nutrition as a sustainable alternative for present meat consumption and production, while also having the potential to meet the Factor 20 challenge. Targeting meat consumption itself, or the production of meat, as environmental improvement strategies was recognised but not included in this case. After a feasibility study a project was developed to elaborate the option of Novel Protein Foods that was co-financed by major companies from the food supply system in the Netherlands and bringing together consumer scientists, economists, food technologists and Life Cycle Assessment (LCA) researchers. During the project a more detailed future vision was developed. The key of the future vision was that Novel Protein Foods could replace 40% of meat consumption in 2040. Looking from a backcasting perspective, this implied that food technology had to be improved considerably enabling to produce protein foods similar superior in taste and structure as meat, while it was also assumed that Novel Protein Foods should have similar nutritional value as meat. It also implied cultural changes not only related to the role and status of meat and meat consumption, but also related to the role and status of protein foods from other sources than animals. This future vision also implied structural changes, as the meat sector would decrease, while new protein food chains would emerge.

It was concluded when finishing the project in 1996 (Quist et al 1996), that these new protein foods could be produced 10-30 times more environmentally efficient, compared to production of pork meat at that time. It was also concluded that NPFs could be attractive to both consumers ('taste is the deciding factor') and producers ('lower production costs than of meat'), while socio-economic effects remain relatively limited when compared to present autonomous development and foresights. In addition, it was concluded that the development and large-scale introduction of NPFs in the future is possible, but that new knowledge, research and development were required (STD 1997, Quist et al 1996). Results included a set of different NPFs analysed with respect to consumer acceptance and benefits, environmental impact, production costs and socio-economic effects and opportunities; R&D-programmes to develop lacking fundamental and applied knowledge, and a development trajectory towards 2040 containing 7 clusters of follow-up and implementation activities for both the short-term and the long-term (see Table 2). Furthermore, a strategy was proposed that NPFs would be especially beneficial in the processed segment (burgers, sausages, etc) and as assembled dishes and foods like pizzas and ready-mades.

Table 2: Action agenda for development and introduction of Novel Protein Foods

1. Communication with the general public and supply of adequate information
2. Professional education and transfer of new knowledge
3. Consumer research and development marketing instruments
4. Fundamental research and chain organisation
5. Novel Protein Foods product development (both as food *and* as ingredient)
6. Improvement environmental reduction factor and improving LCA-instrument
7. Necessary legislature and social measures (facilitating both the growth of a novel protein food chain and the decrease of the meat sector).

4.4. Backcasting approach in the Novel Protein Foods case

The previous section clearly showed that the normative future vision was a central element and could be used for identifying necessary major technological, cultural and structural changes. Those findings were elaborated in a set of promising NPFs based on several vegetable and microbial sources. So, next to developing and designing a future vision and its backcasting, elaboration and research activities took place. The latter included that several NPFs were designed and defined in the sense of food products for which specific design tools were applied by the food technology researchers in the project. Furthermore, defining the set of NPFs enabled to detail the future vision of 40% meat replacement and to assess socio-economic consequences and environmental improvement, while the set of products enabled the study for each NPF of its consumer attractiveness, the environmental improvement factor and the production costs.

So, the option of Novel Protein Foods was explored using a combination of design, backcasting and analysis activities before defining a possible development trajectory containing the 7 clusters of activities in Table 2. The list of activity clusters in Table 2 can be seen as a policy and action agenda for sustainable technological development around the option of Novel Protein Foods. The elaboration of this agenda included the societal groups and specific stakeholders who should take the lead in certain clusters or specific activities.

From the viewpoint of stakeholder participation, it is important to present how stakeholder involvement was organised? First of all, relevant research bodies did the research during the project. This was not only done from the viewpoint that researchers and their institutes would bring relevant knowledge, this was also important from the viewpoint that research institutes are important players in the relevant national innovation system. Second, participation was guaranteed trough funding from relevant ministries and two major private industries. Those stakeholders were members of an advisory board, which was extended with key persons from research and public interest groups. Third, Constructive Technology Assessment was used for involving a broader range of stakeholders from the four societal groups distinguished earlier. The "Future Images for Consumers" (Fonk 1994)) methodology was applied (Weaver et al 2000: Chapter 6, Fonk & Hamstra 1996) for organising and structuring a dialogue among the stakeholders involved. Participating stakeholders met during three workshops in which progress, opportunities and dilemmas were discussed, while it was completed with a statement containing both agreements and disagreements. Fourth, there were less focussed ways of involvement through for instance consumer research, general communication, etc. In addition, the importance of participation for achieving stakeholder learning has been explained. It was therefore evaluated if learning, especially on the higher or conceptual level, took place (Loeber 1997). It was found that this was indeed the case.

4.5. Follow-up and impact

An important premise underpinning backcasting is that conceptual or higher order learning by stakeholders is a condition for endorsement and supporting/participating follow-up and impacts. While follow-up relates more to concrete activities, impact concerns a broader term that includes learning effects and what is sometimes called the utilisation of knowledge. So it is interesting to discuss to which extent follow-up has been accomplished (see also Loeber 1997). First of all, a large research project (entitled "Profetas", www.profetas.nl) is carried out dealing both with the technological issues and the socio-economic and cultural aspects of the production and consumption of NPFs. Several major food companies in the Netherlands are involved in this project and are also working on this type of foods in their own R&D. Furthermo-

re, NPFs are discussed occasionally by a major supermarket chain in their consumer magazine, while this issue is incorporated in the sustainable consumption activities of the Ministry of the Environment. Further, several new stakeholder co-operations are emerging that become visible at meetings and conferences focusing on the production and the consumption of NPFs, and bringing together producers, public interest groups (including environmental groups and the association for vegetarians), consumer organisations and representatives from research bodies and other chain parties. In addition, the interest of consumers for protein foods, not being meat from animals, is growing due to recent affairs like BSE and the mad cow diseases. However, it must be realised that the growing consciousness due to this is not automatically long lasting. On the other hand, from history it is known, as for instance shown by Geels (2002) and numerous others, that contextual factors can be important for transitions and transformations.

The emerging question is now if the follow-up and impacts are the signs of an emerging transformation or transition of the present meat production and consumption system towards a more sustainable socio-technical system having a considerable share of Novel Protein Foods (or 'meat-like products' as NPFs were originally called).

Though a major research project strongly entrenched in the innovation system for food production and agriculture, specific development projects and occasional recurring discussions are good results, it might be not enough to ensure the societal embedding of this innovation as it is the majority of ordinary consumers which must change their consumption pattern before the environmental promise of NPFs will be realised. More research is necessary to investigate how, under which conditions, a transition to a NPF system could be brought about. Backcasting can (again) play a role in this follow-up research.

5. Case II: SusHouse project

The second case presented and discussed here is the case study on Shopping, Cooking and Eating, which was carried out in the Netherlands as part of the SusHouse project. This case took the demand side of the food production and consumption system as a starting point for exploring future sustainable options.

5.1. Background

The EU funded SusHouse (Strategies towards the Sustainable Household) project, was concerned with developing and evaluating strategies for transitions to sustainable households. The starting point of the SusHouse project was that a combination of technological, cultural and structural changes is necessary to achieve a Factor 20 environmental gain in the next 50 years through system innovations, while both consumption and its interconnection with production through products and product usage taking into account (Green and Vergragt 2002, Vergragt 2000, Quist et al 2001). Another important starting point was to involve stakeholders in the process of (re) designing the fulfilment of a household's needs compatible with the concept of sustainable development. Three household functions were studied (1) Clothing Care, (2) Shelter and (3) Shopping, Cooking and Eating (SCE) or Nutrition, while six research groups in five European countries were involved (Vergragt 2000).

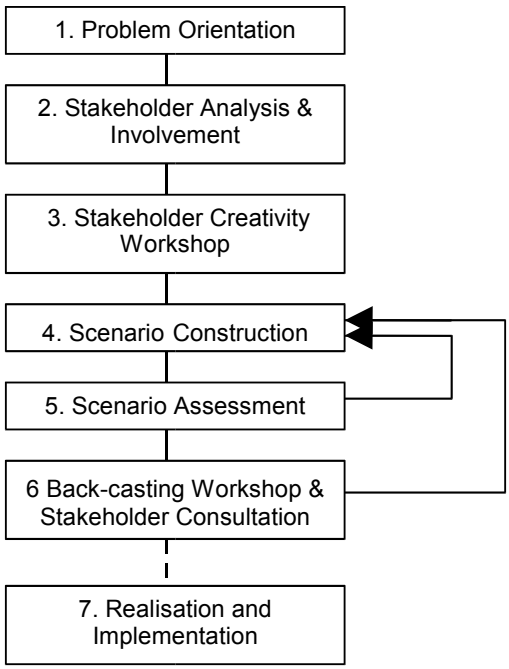
5.2. Approach

The Project's approach was earlier applied from in the Sustainable Washing project at the STD programme (Vergragt and Van der Wel 1998) before it was developed,

elaborated and extended further. Here we describe it briefly. For each household function studied in each country, an extensive process of *stakeholder identification* was performed, covering stakeholders on the demand side, the supply side, research bodies, government and public interest groups. Selected stakeholders participated in stakeholder *creativity workshops* aimed at identifying sustainable ways of future function fulfilment. The results were used for *scenario construction*. These normative scenarios were not only assessed in terms of environmental gain, consumer acceptance and economic credibility – this part of the SusHouse approach is not dealt with in this chapter -, but they were also used for a scenario-specific second round of stakeholder identification. Old and newly identified stakeholders were invited to a second set of workshops in which scenarios and assessment results were discussed, followed by developing implementation proposals, research agendas and policy recommendations for achieving the scenarios. Objectives of case studies in the SusHouse project included normative scenarios for the fulfilment of functions of the sustainable household, endorsed by a range of social partners, scenario assessments and construction of follow-up agendas containing implementation proposals, policy recommendations, research question for solving knowledge gaps and (new) stakeholder alliances (Vergragt 2000).

The Figure below shows the overall SusHouse approach existing of 6 stages, while the 7th stage 'Realisation and Implementation' was actually not part of the SusHouse project. It was an important aim of the project to stimulate and prepare follow-up, but achieving it was not part of the project. A more extensive elaboration on the overall SusHouse methodology are given by Vergragt (2000), Quist et al (2000), Quist et al (2001) and Green and Vergragt (2002).

Figure 2: The stages in the SusHouse project.



Next, table 4 shows how the generic backcasting approach proposed earlier relates to the SusHouse approach discussed here. It shows clearly that the steps of the Sus-House approach can be positioned in the backcasting approach proposed in this chapter.

Table 4: Comparison of general backcasting approach and the SusHouse approach

Backcasting approach	**SusHouse approach**
1. Strategic problem orientation	Step 1 & step 2
2. Construction of desirable (normative) scenario or future vision	Step 3 & step 4
3. Backcasting stage	Step 4, step 6
4. Elaboration (design *and* analysis) and defining follow-up activities and action agenda	Step 4, step 5, step 6
5 Embedding of action agenda, activities and generating follow-up *and* implementation	Step 6, Step 7

5.3. Nutrition case study in the Netherlands

Scenario construction for Nutritition or SCE in the Netherlands was based on the results of a stakeholder creativity workshop and the Design Orienting Scenario methodology of Jegou and Manzini (2000) and its elaboration given by Young et al (2001). During the workshop stakeholders from different societal groups generated ideas for future sustainable fulfilment of the SCE function guided by the question 'How can we eat in a sustainable way in 2050'. Generation of ideas was followed by clustering and elaboration of proto-scenarios by the participants. Table 5 summarises the SCE scenarios briefly, while Table 5 shows key features of the three scenarios.

Table 5: Brief descriptions of the three scenarios

Intelligent Cooking and Storing (ICS) is about a household that can be characterised by high-tech, convenience, do-it-yourself and a fast way of living. Kitchen and food management is optimised with help of intelligent technology, which also organises ordering (electronically), and delivery with help of a so-called Intelligent Front Door. Water and energy are re-used where possible through cascade usage. Meals are either based on a mixture of sustainable ready-made and pre-prepared components (including vegetarian or novel protein foods replacing meat) or ready-made meals containing a microchip communicating cooking instructions with the microwave oven. Packaging is biodegradable and contains a (plastic) microchip with relevant consumer information about origin, treatment and preparation.
Super-Rant (SR) combines elements from the present supermarket and restaurant, but these are shaped into a neighbourhood food centre within a compact city. Here you can go for a meal (e.g. by a subscription to the neighbourhood cook), for food shopping, to purchase a take-away meal or to eat together for different prices. In many households only the microwave oven, a water cooker and a small fridge are left. Waste is collected for local energy production. Food is grown in a sustainable way.
In **Local and Green (L&G)** household members grow a considerable share of their foods themselves. Additionally, they buy and eat seasonal foods that are locally grown and purchased at local shops, small supermarkets, or are bought direct from the grower or hobby garden as 'fresh' unprocessed ingredients. Regional specialities are important and are consumed in the region by both inhabitants and tourists. Imported products are still available but expensive, because environmental costs are incorporated in the price. Furthermore, there is a strong green consumer demand in this scenario.

These scenarios can be seen as depicting more sustainable alternatives for possible present and future ways of living. These are not meant to select the most sustainable scenario and develop a strategy to bring everyone towards the most sustainable scenario. That would be as worse as any traditional blueprint planning and would deny individual autonomy and present plural society.

Table 6: Stakeholder panorama and backcasting results for the Intelligent Cooking and Storing scenario

Stakeholder panorama Key stakeholders for realisation of this scenario include consumers, retailers, food processors & manufacturers, packaging producers, kitchen equipment & appliances producers, government. **Necessary changes (preliminary back-casting analysis)** • Technological: novel kitchen technology **and** appliances (including a huge efficiency increase), new ICT for kitchen systems and production chain management, plastic chips, biodegradable packaging, cascade usage for water and energy, sustainable transportation, distribution and delivery systems. • Cultural/behavioural: sustainability for granted, further shift towards ready-mades and convenience, acceptance of new technologies, shift towards more sustainable substitutes (e.g. vegetable based Novel Protein Foods in stead of meat), shift towards services. • Structural/Organisational: role supermarkets will change due to large scale delivery and change towards food management services, kitchen manufacturers deliver complete automated systems that communicate instead of single kitchens and single appliances, close co-operation and joint management over the complete production chain and information available to consumers; sustainable food production (regional or efficient large scale production where this can most environmentally efficient).

Table 5 uses the Intelligent Cooking and Storing (ICS) scenario as an example to show the stakeholder panorama and results from a preliminary backcasting analysis based on an identification of the for achieving the scenario. Backcasting analysis refers here to the analysis, which is done by looking backwards from the scenario using the leading question 'What technological, cultural, and institutional-organisational changes are necessary for realising this scenario'.

Three scenario assessments were conducted The first is an *environmental assessment* using a system analysis approach with indicators to assess if the scenarios achieve a Factor 20 reduction in household environmental impacts. The *economic assessment* used a questionnaire to assess each scenario for economic aspects like competition, employment etc. Finally, the *consumer acceptance analysis* used consumer focus groups to evaluate the acceptability of the scenarios to consumers and to identify adopter profiles. In short, the assessments revealed that the Intelligent Cooking & Storing scenario and the Local & Green scenario would reduce the environmental burden considerably. However, quite surprisingly, for the Super-Rant scenario it was found that - using energy data from present restaurants - the energy requirement would even increase. It was concluded that better data would be necessary, and that there is a huge potential for environmental improvement in the Dutch food service sector.

Scenarios and assessment results were fed into a second stakeholder workshop focussing on implementation, follow-up and the construction of action and follow-up agendas. In addition, implementation proposals were elaborated, policy recommendations were developed, and even new innovative ideas were proposed. Furthermore, the unprocessed results contained the 'raw material' for policy recommendations and also for the construction of an action agenda.

5.4. Follow-up and impact

So, what kind of follow-up was achieved in this case (Quist et al 2002)? Concrete stakeholder co-operation, new partnerships and alliances around proposals were scarce in the last workshop. Nevertheless, there was considerable interest from stakeholders, and also concrete intentions to continue the process aiming at concrete follow-up, co-operation around concrete proposals and activities, and at imbedding of

results in processes taking place in other networks. Additional activities after the workshops appeared therefore to be necessary for realising follow-up towards implementation. Furthermore, a number of initiatives were started, but it proved to be hard to get these funded.

However, concrete co-operation developed between stakeholders around ideas and proposals. It led for instance to a workshop focusing on domestic appliances for treating Novel Protein Foods at home, organised jointly by a research body and a company, while other stakeholders (many of them not involved in the SusHouse project) were recruited. After the workshop the organising parties developed a concrete research proposal on optimising kitchen appliances and food supply chains from an environmental point of view. It was supported by a number of stakeholders from different societal groups. Furthermore, the Dutch research group originally involved in the SusHouse project developed also new proposals including a programme proposal for a transition towards sustainability in eating-out and the food-service sector. It has been nominated for funding and aims at bringing together innovative parties from the food-service sector in the Netherlands. Finally, results and conclusions from the SusHouse SCE function were used as input for the policy process of the Dutch Ministry of the Environment on sustainable food consumption.

Nevertheless, the SusHouse project can be characterized as a successful application of backcasting for generating ideas and bringing together stakeholders around these ideas. However, in terms of implementation, kicking off concrete innovations, multi-stakeholder coalitions, or systemic changes, the project has not reached its aims. Apparently, also here more is needed in terms of governance or innovative capacity.

6. Conclusions

6.1. Backcasting approach

This chapter has presented participatory backcasting as a novel, innovative and promising approach for long-term strategising for sustainability, based on stakeholder involvement, construction of normative sustainable futures, stakeholder learning, in combination with design and analysis activities an construction of follow-up agendas meant for guiding implementation. Participatory backcasting has potential for planning in sustainable development, for identification and exploration of promising sustainable technologies, sustainable system innovations and transitions, for guiding technology choices and for generating alternative more sustainable trajectories for present dominant trends and developments.

We have described how backcasting originated from the 1970s and how it originally was developed as an alternative for traditional forecasting and planning. Its original focus was on policy analysis for energy planning. It evolved to sustainability issues, while later on utilisation of knowledge and the implementation of outcomes became much more important. Participatory backcasting using normative scenarios should be seen as rather opposite to the so called strategic scenario approaches using a range of possible futures and having become popular after the success of Shell – though there is agreement on the importance of learning (see e.g. Van der Heijden 1996). One of the differences is that Shell uses the scenarios to scan and understand possible changes in its business environment, so that the company can anticipate on these. This can be contrasted to developing normative visions on the future direction of a company or of society as a whole.

We also have found that backcasting can refer to a concept or philosophy, a study, an approach, a methodology, or an interaction process among participating stakeholders. In addition, it can refer to an assessment/analysis (sometimes referred to as

the backcast) or to the specific step of looking back from the desired future within an overall stepwise (but iterative) approach or methodology. This implies also that backcasting can be dealt with on the conceptual or holistic level, the level of social or multi-actor processes, the level of overall approaches and methodologies containing of multiple steps, methods and instruments and on the level of specific steps, methods or instruments within such an overall approach or overall methodology. So, this makes very clear that backcasting is more than looking back from a desirable future. However, it also implies that further work needs to be done to define the approach and to distinguish this clearly from other elements within the approach for which also the term backcasting is used.

Participatory backcasting has a number of key features and elements. First, there is the explicit normative nature of backcasting approaches, which can be made explicit in the early beginning of the backcasting process, and which leads to normative future visions or normative scenarios. Other important elements include broad stakeholder participation – which is meant from the major societal groups distinguished here: companies, research, government and public interest -, conceptual learning by stakeholders involved - with respect to sustainability solutions, possible sustainable futures and the possible contributions from themselves and other stakeholders, and last but not least the process and its transparency. . Important background assumptions are a social shaping or constructivist perspective, the importance of interaction among participating stakeholders, and the recognition that existing rules and structures are not or not well equipped to deal with sustainable development and sustainable solutions.

This chapter has also proposed a general scheme for participatory backcasting consisting of five stages, while distinguishing four major activities: 1) Orientation; 2) Design; 3) Assessment; and 4) Participation. This implies that different tools and methods are necessary within a backcasting framework for which also four groups have been proposed: design tools; participatory tools; assessment tools and process (management) tools. It is important to realise that the backcasting approach is not only multi-disciplinary, but also trans-disciplinary. This implies not only clear knowledge demands, but equally important – and even more difficult to be met - clear process demands.

It seems possible to position backcasting approaches in a family of approaches using normative scenarios and stakeholder participation. For instance, Rotmans et al (2000) report on normative scenarios for sustainable areas in Europe in which stakeholders were involved, while Street (1997) reports on the use of scenario workshops as a participatory approach to sustainable urban living. Concerning the latter, which involved four groups, namely citizens, local policy makers, the private sector and technology experts, the scenario workshop approach included (1) creating visions and (2) looking at ways of turning those into reality. However, further study is necessary on how these relate to backcasting.

6.2. STD Novel Protein Foods case and SusHouse Nutrition (SCE) case

Concerning the NPF case at the STD programme, it can be concluded that backcasting was applied successfully and led to a sustainable future vision, stakeholder involvement from the four major societal groups distinguished here: companies, research bodies, government and public interest groups. The vision and elaboration also led to the identification of attractive NPF examples from different vegetable and fungal sources analysed for their consumer aspects, cost aspects, environmental potential, possible socio-economic impacts and the fundamental and applied knowledge that is presently lacking. To bridge the knowledge gap R&D programmes were defined and elaborated, while also a possible development trajectory was sketched.

Furthermore, considerable follow-up was realised both in public R&D and in private R&D, while also NPF related activities were found at the ministry of the Environment and public interest groups.

Concerning the SCE case at the SusHouse project, it can be concluded that backcasting was also successfully applied and led to several sustainable future visions and stakeholder involvement from the four major societal groups. The sustainable future visions were successfully elaborated and analysed on environmental improvement, consumer attractiveness, economic aspects, the necessary changes for realisation and action agendas and implementation proposals were defined and elaborated during stakeholder workshops. However, follow-up was much smaller than in the NPF case.

So, from the two case studies reported in this chapter it can be concluded that backcasting can be a strong approach for developing alternative sustainable future visions utilising the expertise and knowledge of a broad range of stakeholders. Backcasting analysis, further elaboration of attractive clusters and ideas and additional assessments can further lead to definition of follow-up agendas, containing R&D-activities and programmes and other important activities concerning implementation, strategy development, policy recommendations and short term proposals attractive for single stakeholders or co-operating stakeholders. However, the cases reveal differences. A major difference is the difference in follow-up and implementation. While the NPF case of the STD programme appeared to be rather successful in this sense, the SCE case of the SusHouse project seems to have much less impact concerning follow-up, stakeholder endorsement and conceptual learning among stakeholders.

The question emerging now is what could be a possible explanation for this difference between the two cases? Both were successful in involving stakeholders and in constructing, elaborating and analysing sustainable alternatives for future need and function fulfilment. Both cases led to follow-up agendas and ideas for implementation and activities, but only in case of the Novel Protein Foods, there was obviously utilisation of the results and concrete follow-up and implementation of the outcomes. Was it the difference in the organisational and institutional setting? Five ministries establishing the STD programme versus the European Union and academic self-organisation in the SusHouse project? Would it have to do with the type and level of stakeholders involved? Or was how the process is organised and managed decisive? It could also have to do with the system 'outside' the backcasting experiment as it can be both enabling and constraining. Enabling in the sense that it is open for the outcomes and constraining in the sense of ignoring or fighting back. No clear answer can be given, but further study could increase our understanding. So, further evaluation of existing backcasting experiments and backcasting practices seems to be necessary, and it might give answers to questions raised here, and might contribute to improving the effectiveness with respect of follow-up and explanation through improving our understanding of the factors enabling and constraining this. A research agenda has been proposed for this (Quist 2003).

Another, more fundamental, question that arises here is the viability of a backcasting approach as a first step to a large-scale structural and cultural social and technological change process (called a 'transition' in present Dutch policy literature (Rotmans et al 2001). Obviously, backcasting works well as a tool of generating visions and scenarios that do not fit in present-day trends, and that spur stakeholders to think 'out-of-the-box'. However, the implementation of major change is a long-term process involving innovation and governance by multiple stakeholders. Elsewhere one of us (Vergragt 2001) has argued that future visions, which are shared among stakeholders, are a necessary but not sufficient condition for achieving system innovation towards sustainability. Stakeholder management is also very important and should take into account the culture and the interests of stakeholders, trying to understand their motives for collaboration, and understanding in which phase of the process they

can play a role. Further dealing with stakeholders in these types of innovations is extremely time-consuming and therefore costly. This is increasingly the case when future options deviate from existing development paths and explore new cultural and structural options.

6.3. Backcasting and related approaches

It is possible to relate backcasting to at least three categories of approaches. The first one is scenario-based foresighting approaches. These include the already mentioned strategic scenario approaches as known from Shell, the socio-technical scenario approach as proposed by Elzen et al (2002), and the earlier varieties of backcasting. However, in this type of approaches, the analytical relevance is in general stressed and construction is in general done by the researchers themselves sometimes based on expert consultation, while one of the core issues in participatory backcasting is broad stakeholder involvement representing different mindsets.

The second category is the one of participatory approaches like practiced in Constructive Technology Assessment. Here, the core issue is broadening the development and design process of technologies and artefacts with societal actors and aspects. However, it does not automatically lead to sustainability as it depends on the incorporation aspects and the participating actors, and it does not automatically include normative visions as a starting point. An emerging methodology is Strategic Niche Management (e.g. Hoogma et al 2002). Strategic Niche Management refers to experimenting with new technological options in a space protected (by the government) from market pressures, in order to enable stakeholders (both producers, users, regulators) to learn about the new technology and the embedding in its context. This approach is not so much strategic and long-term oriented, but focuses on concrete technologies and artefacts that are already available. SNM may be part of a long term strategy which includes implementation of new technologies, as for instance can be set out with participatory backcasting. However, it is yet unclear how the removal of the protection mechanisms (as suggested in SNM) could take place in a balanced way, on the one hand without killing the technology in an early phase, on the other hand without offering protection that cannot be continued in the long term.

A third category related to backcasting includes all participatory approaches using normative future visions, while ensuring broad stakeholder involvement. Examples have already been mentioned (e.g. Street 1997, Rotmans et al 2000). An important emerging one is transition management as proposed by Rotmans et al (2001), which currently has a strong influence on environmental policy in the Netherlands. It is also meant for achieving transformations or system innovations towards sustainability taking at least decades. Like backcasting it has characteristics like (Rotmans et al 2001) long term thinking as a framework for guiding or shaping short-term actions, a focus on learning and mutli-actor involvement. Participatory backcasting, however, does not focus so much on keeping a large number of options open, nor does it include improvement of existing systems. The key of backcasting is to identify possible alternatives and to explore and develop trajectories (recognising the constructive and evolutionary nature of such trajectories). Furthermore, transition management emphasises the governance and leading role by the government, while participatory backcasting, as dealt with in this chapter, emphasises that the governance of system innovations towards sustainability needs to include its multi-actor character (in a smart way). Furthermore, participatory backcasting assumes that future visions can be seen as multi-actor constructed and may therefore have the potential to develop into so called guiding visions or images (Grin & Grunwald 2000). The latter is much more difficult, if all options are kept open as long as possible, as is proposed in transition management.

Despite these differences, it might be possible that transition management and participatory backcasting could be seen as complementary. Backcasting seems to be a strong approach for constructing future visions endorsed by a wide range of stakeholders and for identifying and exploring alternative socio-technical systems, while transition management might be strong in implementation and managing the implementation process necessary for realising the transition on the long term. However, further study is needed in order to improve our understanding on this issue.

6.4. Backcasting: relevance for government and governance

Change processes towards sustainability on the level of system innovations require the participation and contribution of all four societal groups distinguished in this chapter, which were business, government, research and the public & public interest groups. Business is important for producing sustainable products and services. Researchers and research bodies are important for developing the knowledge necessary for future sustainable alternatives. The public is important for at least two major reasons: democratic legitimisation and as consumers, as sustainable alternatives need to be consumed before the environmental benefits can be realised. In general, it can be said that it is important to mention that it is not only important that societal groups or specific stakeholders play their role, but also that interaction takes place between and among stakeholders contributing to shared visions and, if appropriate, joint or co-ordinated action.

But what should be the government role[2] and what kind of governance could facilitate system innovations or transformations towards sustainability? We argue that the role of the government is indispensable because of the long time horizon, the complexity of the processes, and the need for an actor that guards the general direction of sustainable development. However, government needs to reflect upon its own functioning, and has to develop a concept of governance that is suitable for influencing transitions.

Government participation seems to be crucial for further development, implementation and embedding of the results of a backcasting experiment. Government could be part of backcasting in various roles. First of all, like in the STD Programme, government agencies could actually set up and finance backcasting activities as part of their long-term oriented strategic research policy, for instance for sustainable development. In this way, backcasting activities acquire the credibility and the legitimating that is necessary to attract major stakeholders. As an example, in the STD Program it was a very important feature that the Programme was organised by five Ministries jointly, and that they accepted the challenge of factor 20 environmental efficiency as a long-term goal as a legitimate starting point for the Programme. Secondly, government agencies and employees can participate in workshops and other activities that are part of the backcasting activities aiming at system innovations towards sustainability. They can participate in their role as experts, as representatives of their department or agencies, or as individuals that can perform boundary-spinning roles, connecting the thinking within government agencies with thinking in other multi-stakeholder arenas. Thirdly, government agencies can set rules and regulations and more generally change the regulatory environment in order to endorse projects and activities that are part of the backcasting endeavour. For instance, in the case of Novel Protein Foods, governments could regulate the meat chain and the alternative (novel protein) chains in such a way that the more sustainable alternative might acquire a competitive advance with respect to the incumbent production and consumption chain. As an example, the California Zero Emission mandate of 1990 has spurred a

[2] It should be realised that governments are plural in itself and that therefore specific actors or stakeholders can be distinguished in the government.

lot of research and development activities both in electric vehicles and in fuel cell developments. Here, backcasting can be used again for exploring possible zero emission futures.

Concerning the governance of system innovations or transformations towards sustainability, Grin et al (2003) have explored the contours of a novel governance policy concept for governing system innovations or transitions. They argue that governments need to develop a third generation of environmental policy in addition to the second generation based on stakeholder orientation and social learning. The boundaries for this second-generation environmental policy have been reached because of structural impediments in society: the physical infrastructure, social conventions, existing regulations, available knowledge and the knowledge infrastructure. The challenge is how to formulate a policy that addresses this cultural and structural entrenchment without falling into the trap of planning by blueprints They argue that it requires not a huge planned attack on the existing system, but system changes may be brought about by "*….concrete contextual practices that, to a certain extend, do not follow the existing rules….".* Various practices may reinforce each other and eventually may lead to a system innovation. For the government there are two roles: foster innovative practices, and foster mutual reinforcement of these practices. The former was also recommended elsewhere (Irwin et al 1994, Vergragt 2000). Mutual reinforcements of innovative practices may be achieved by developing connective infrastructures, regulation on a more general level, technologies that fulfil social needs in various contexts, and research programs aimed at investigation of knowledge gaps. It may be added that forms of network management aiming explicitly at connecting innovative practices may be useful here.

So, what does this mean practically in cases of plural multi-actor contexts and multi-actor processes in our constructive world, while there are no rule sets and institutions available (as mentioned already in Section 3.4 when dealing with the theoretical aspects of backcasting)? It should aim at higher order institutional and policy learning through participatory development and exploration of long-term future visions. However, it needs to be investigated further how future visions play a role in contextualising and connecting individual innovative practices, and how to provide them with a meaning that goes beyond the innovative practice itself.

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