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Past and future of backcasting: The shift to stakeholder participation and a proposal for a methodological framework

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Abstract

This paper deals with the past, present and future of backcasting. After having reviewed the origin and developments since the 1970s, it is concluded that several varieties can be distinguished and that a shift has been made to broad stakeholder participation and towards a focus on realising follow-up and implementation. A methodological framework for participatory backcasting is proposed consisting of five stages and four groups of tools and methods that can be applied and are necessary in such a framework, while different type of goals are possible. The paper reports on two cases in which participatory backcasting was applied, the Novel Protein Foods project at the Sustainable Technology Programme in the Netherlands and the Nutrition case study of the Sustainable Households (SusHouse) project. The paper concludes that these have resulted in broad stakeholder involvement, sustainable future visions, analyses and construction of follow-up agendas, but that follow-up and impacts are quite different. A research agenda is proposed to compare and evaluate backcasting studies and their impacts after a couple of years, while the future of participatory backcasting is also briefly discussed.

1. Introduction

Radical changes to present production and consumption systems, especially in the developed world, are required to achieve sustainable development. These changes on a

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system level are referred to as industrial transformations, while also terms like sustainable system innovations or transitions towards sustainability are being used. Such system changes or transitions require combinations of technological, cultural, social, institutional and organisational changes, while affecting many stakeholders when diffusing into society and involving complex processes of social change on the long term. However, sustainable system innovations (or industrial transformations or transitions) are very complex phenomena, due to the inherent uncertainty of the future and the inherent ambiguity of stakeholders having different value sets and mental frameworks.

Questions have been raised about what kind of approaches could be applied to such complicated issues, how to identify attractive and desirable system changes (system innovations, industrial transformations or transitions), how to explore these, how to get these started and implemented in practice and about the role of different stakeholder groups and stakeholder co-operation. According to Quist et al. [1, p. 274] bringing about system innovations requires *new integrated approaches* that should at least combine:

- Involving 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 components.
- Taking into account the demand side and the supply chain as related production and consumption systems.

An emerging and currently widely discussed approach for achieving changes on the level of systems is transition management [2]. Backcasting has also been proposed as an approach that meets the requirements mentioned above and could be used for dealing with the questions raised. It has been proposed and tested in the Netherlands as a promising participatory planning approach to identify and explore these 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 at 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, little has been done on comparing different backcasting studies and evaluating lasting impacts, and how it relates to other recently emerging approaches like transition management and strategic niche management.

This paper 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 have emerged over several decades. It elaborates on how backcasting can be seen as an integrated approach for bringing about sustainability on a system level and have a methodological framework for participatory backcasting. It also describes and compares two backcasting experiments and their impacts and follow-up.

The paper is structured as follows. Section 2 provides a brief history of backcasting starting with its origin in the 1970s in energy studies and its further elaboration and application to sustainability issues especially in Sweden, Canada and the Netherlands and

the shift to stakeholder involvement. Next, Section 3 elaborates on methodological aspects of participatory backcasting. It proposes a methodological framework for participatory backcasting. Sections 4 and 5 present and analyse two participatory backcasting cases from the Netherlands in the area of food production and consumption. They are derived from the governmental Sustainable Technology Development (STD) Programme [3] and the international research project 'Strategies towards the Sustainable Household' (SusHouse) [4,5] and describe how backcasting has been applied and what kind of follow-up and implementation has been achieved (so far). This is a very different evaluation than previously. Finally, Section 6 contains conclusions and discusses the future of backcasting and why its impacts should be investigated after a couple of years.

2. Back-casting: A brief history

2.1. Backcasting in energy studies and soft energy paths

The origin of backcasting is in the 1970s, when Lovins [6,7] proposed backcasting as an alternative planning technique for electricity supply and demand [8,9]. While Lovins [6,7] originally called the method 'backwards-looking analysis', Robinson [8] proposed the term 'energy backcasting'. Assuming that future energy demand is mainly a function of current policy decisions, Lovins 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 focusing only on likely futures. The assumption was that 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 that future.

Energy studies using backcasting were, at that time, especially concerned with so-called soft energy (policy) paths, which took as a starting point a low-energy demand society and the development of renewable energy technologies. At that time, these studies were a response to regular energy forecasting. These were based on trend extrapolation and projected rapidly increasing energy consumption and focused strongly on large-scale fossil fuel and nuclear technologies to deal with this estimated growth. This response led to numerous studies on soft energy paths [7,8] and studies comparing these to regular ones [10,11]. Interestingly, backcasting has regularly been applied in energy studies since then [9,12].

The focus of energy backcasting was on analysis and deriving policy goals, while the *backcasts* of different alternative energy futures were also meant to reveal the relative implications of different policy goals [8, p. 337–338] and to determine the possibilities and opportunities for policy making. From the beginning, Robinson has strongly emphasised that the purpose of backcasting was not to produce blueprints, but to indicate relative feasibility and implications of different energy futures (including social, environmental and political implications) on the assumption of a clear relationship between goal setting and policy planning [13, p. 823]. Robinson [8] 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 [9] adapted the energy

backcasting approach, aiming to reconcile the electricity industry with sustainable development. He takes into account 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.

In summary, the early focus in backcasting was on exploring and assessing energy futures and on its potential for policy analysis in the traditional sense of supporting policy and policymakers using mainly a governmental perspective.

2.2. *Backcasting for sustainability*

Those applying backcasting must have realised that it could have a much wider potential for application, due to its characteristics and its normative nature. For instance, Robinson [14] also dealt with wider conceptual and methodological issues of backcasting, including the role of learning (or unlearning with respect to existing dominant views) about the future, the issue of broadening the process to a larger group of potential users and how to alter the hegemony of existing dominant perspectives. Elsewhere, Robinson [13] mentioned that backcasting is not necessarily only about how desirable futures can be attained, but also possibly about analysing the degree to which undesirable futures can be avoided or responded to.

Robinson's paper [13] also marked the move towards sustainability applications of backcasting and illustrates the interest in Sweden, as the paper reports on a study funded by the Swedish Energy Research Council. In Sweden a strategic interest in alternative energy futures had developed [10,11], which was followed by substantial efforts in specific backcasting studies and conceptual development [15–18]. Backcasting has been applied in Sweden for sustainable transportation systems [17,18], for making companies sustainable [16,19] and for exploring futures for regions like the Baltic Sea [20].

Dreborg [15] argues, for instance, that traditional forecasting is based on dominant trends and is therefore unlikely to generate solutions based on breaking trends. Backcasting approaches, due to their normative and problem-solving character, are much better suited for long-term problems and long-term sustainability solutions. He also views upon backcasting as an approach instead of a method. Furthermore, backcasting studies should aim to provide policy makers and an interested general public with images of the future as a background for opinion forming and decision making. Interestingly, Dreborg emphasises that our perception of what is possible or reasonable may be a major obstacle to real change—which is in line with earlier remarks of Robinson [14] about (un)learning and the dominance of existing perspectives. Scenarios of a backcasting project should therefore broaden the scope of solutions to be considered by describing new options and different futures. Dreborg also argues that backcasting is especially promising in case of complex problems, a need for major change, dominant trends are part of the problem, externalities that cannot be satisfactorily solved in markets and long time horizons. Sustainability problems clearly combine all these characteristics [15].

Dreborg [15] also focuses on the conceptual level beyond the stepwise method of Robinson and relates backcasting to the field of Constructive Technology Assessment (CTA) [21]. He distinguishes between the analytical side and the constructive process oriented side. With respect to the practical and analytical side, the main result of backcasting studies are alternative images of the future, thoroughly analysed in terms of their feasibility and consequences. With respect to the process and constructive-oriented

side, backcasting studies should provide an input to a policy developing process in which relevant actors should be involved. Results of backcasting studies should therefore be addressed to many actors, including political parties, governmental authorities, municipalities, organisations, enterprises and the general public that needs to be well informed.

Also working within the Swedish backcasting community, Höjer and Mattsson [18] suggest that backcasting and different forecasting approaches are complementary, favouring backcasting particularly in cases where current trends are leading towards an unfavourable state, which is in line with Dreborg's argument [15]. They therefore added a step in their backcasting approach in which forecasts and the desired vision are compared. If the vision is unlikely to be reached according to the most reliable forecasts, model calculations and other estimates, the purpose of the backcasting study should be to generate images of the future or scenarios that fulfil the targets. Furthermore, Höjer and Mattsson [18, p. 630] also emphasise the importance of scrutinising how to attain a future state that has been identified as desirable. This includes working back from that desirable future to check the physical and social feasibility of the route towards that future, identifying the necessary measures and actions for bringing about that future and using models and regular forecasting tools for quantifying the consequences of different measures.

In Sweden, backcasting has also been elaborated as a methodology for strategic planning for sustainability in companies [16,19], which has become known as the Natural Step methodology. It has been successfully applied within corporations like Ikea, the carpet producer Interface and Scandic hotels [16], for a detailed account, see [22]. After commitment by the CEO, it involves the participation of as many employees as possible and consultation of all levels in the organisation for generating ideas about how to become a sustainable corporation. It shows that it is possible to apply backcasting both on a system or regional level and on the level of particular organisations.

In summary, since the late 1980s backcasting has been broadened to sustainability issues and to different levels like regions, companies and sociotechnical systems like the mobility system. Furthermore, there were pleas by some Swedish authors like Dreborg [15] for a broadening with actors and participants (compared to the earlier policy orientation of Robinson), but no empirical cases have been identified in the literature. The emphasis in this type of backcasting remains on the analytical side in which most work is done by analysts, sometimes supplemented with some expert involvement, which is very different from broad stakeholder involvement. It was also argued that in case of backcasting for sustainability reports on methods were hard to find [23]. However, it must also be emphasised that this type of backcasting studies has led to interesting results and the approach has been applied in several countries [24–26].

2.3. The shift to participatory backcasting

The shift to participatory backcasting using broad stakeholder involvement started in the Netherlands in the early 1990s. Participatory backcasting has been applied in the Netherlands since then, first at the governmental programme for STD that ran from 1993–2001 [3,27] and in its EU funded spin-off, the research project 'SusHouse' that ran from 1998 to 2000 [4,5]. 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 moving beyond present mind sets and paradigms.

Vergragt and Jansen [27], inspired by the Swedish practice, mentioned backcasting as part of the philosophy of the STD programme. They described the basic idea [27, p. 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 [27] emphasised, like Dreborg [15] in Sweden, the link with CTA [21], including 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 emphasise also achieving implementation and follow-up [28, p. 173]. '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 and iterative.' It implies that many stakeholders are involved and that there is continuous feedback between future visions and present actions. Elsewhere, Weaver et al [3, p. 74], reporting on the approach and the results of the STD programme, describe backcasting as a possible tool for establishing shared visions of desirable future system states and for securing a 'systems' perspective on the transition process, while it can also be of help in defining feasible short-term actions that can lead to trend-breaking change. Weaver et al [3, p. 72–78] also 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, while different tools and methods can be applied within the overall methodology [3,29].

While the focus of the STD programme was on sustainable technologies, the SusHouse project aimed to develop and test strategies for sustainable households in the future. The approach used stakeholder workshops, creativity methods, normative scenarios, scenario assessments and backcasting analysis [4,5] and can be seen as a backcasting approach, though it has also been argued that backcasting was just one of the elements [30]. In the SusHouse project it was originally thought that all backcasting activities could be concentrated in a single workshop. However, it turned out 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 [31]. Furthermore, Quist et al. [31, p. 8–16] stress also the link with CTA [21], the connections with the field of Creative Problem Solving [32] and the importance of (conceptual) learning by stakeholders and involved researchers facilitating the process. Interestingly, Green and Vergragt [5], reporting on the results of the SusHouse project, conclude that stakeholders should not only be involved in constructing normative scenarios, but also in economic and environmental assessments of the normative scenarios. Taking a more reflexive perspective Vergragt [33] emphasises that future visions, which are shared among stakeholders, are a necessary, but not sufficient condition for achieving implementation and follow-up and that it is important to understand the culture and interests of stakeholders and their motives for both participation in the backcasting study and in follow-up activities.

Participatory backcasting has since become a well known approach in the Netherlands and more studies have taken place. For instance, backcasting and normative future visions

have been applied in a strategic shift in the research programmes at DLO, the main Dutch research organisation for agriculture and rural development [34]. Partidario has elaborated and applied an approach similar to the SusHouse methodology for studying future prospects for sustainability in paint chains in the Netherlands and Portugal [35,36]. A participatory backcasting approach has also been applied 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 [37,38]. Furthermore, Rotmans et al. [2, p. 23–24], working on transition management, also refer to backcasting from the future as part of their transition management approach. Jansen [39] paid attention to backcasting in national foresighting programmes and has compared these to backcasting in the STD programme.

It must be noted that the shift to participatory backcasting has also taken place in other countries. For instance, Robinson, elaborating upon his extensive experience in backcasting (e.g. [8,13,14] has also developed backcasting further and has included participation [40]. He emphasises the importance of social learning, interactive social research, and engagement of non-expert users in backcasting studies and has called this 'second generation backcasting'. It has been applied to the Georgia river basin in West Canada, while relating it also to participatory integrated assessment [41]. Interestingly, it uses a modelling tool based on the QUEST approach that enables to engage residents in interactive construction of future images for the river basin, while the user is also asked to evaluate the scenario outputs regarding their desirability and match with personal preferences. As it is possible to iterate by adjusting inputs, it enables the user to continue towards future visions that have a better match with their preferences also stimulating learning considerably [40].

Finally, participatory backcasting was recently also applied in Sweden [42] and in Belgium [43].

3. On some methodological and conceptual aspects of participatory backcasting

3.1. Towards a methodological framework

Though most approaches found in the literature show differences in methods applied, ways of stakeholder involvement and number of steps [3,4,13,16], it has been possible to generalise and translate these into a methodological framework for participatory backcasting consisting of five stages (or steps). These are:

1. Strategic problem orientation;
2. Construction of sustainable future visions or scenarios;
3. Backcasting;
4. Elaboration, analysis and defining follow-up and (action) agenda;
5. Embedding of results and generating follow-up and implementation.

It is assumed here 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 in an overall framework, for instance, the factor 20 at the STD programme (see Section 4). In addition, if there are more than five steps suggested in a

particular backcasting approach, it is usually possible to see specific steps as part of the five stages proposed here. It must also be mentioned that though the approach is depicted as 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. Furthermore, the backcasting process has a dynamic nature, which means that some stakeholders might leave the process and new ones might join it. Backcasting is normative by nature and it is also problem oriented, multidisciplinary and includes stakeholder involvement, which makes it even transdisciplinary. Stakeholders are important, not only because of their context specific knowledge, but also for achieving endorsement for results and realising the proposed action agenda and specific follow-up. Four major societal groups can be distinguished: companies, research bodies, government and public interest groups and the public.

A wide range of methods and tools are necessary in a participatory backcasting framework, while four groups can be distinguished that form together the outline of a toolkit. *Participatory tools and methods* are the first group. This 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 generating stakeholder creativity and tools helping stakeholders in specific backcasting activities and tools for participatory vision and scenario construction. Mayer [44] has provided an interesting overview of participatory tools and methods. Second, there are *design tools and methods.* These are not only meant for scenario construction, but also for elaboration and detailing systems and process design tools. Third, backcasting involves a*nalytical tools and methods*. These relate not only to the assessment of scenarios and designs, like consumer acceptance studies, environmental assessments, economic analyses, but also include methods for process analysis and evaluation, stakeholder identification and stakeholder analysis. Fourth, backcasting also requires *management, co-ordination and communication tools and methods.* This includes methods for communication, for shaping and maintaining stakeholder networks that originate from the backcasting study and for process management [45], while also methods from CTA can be useful [46]. It must be noted that each stage of the backcasting approach generally requires tools and methods from all four categories distinguished, while it is likely that it involves different tools and methods in different stages.

The literature on backcasting shows a considerable goal orientation. However, the focus is on goals connected to the desirable future states. Here, backcasting is seen as a participatory and a process-oriented approach carried out in a project of limited time. So goals should not only reflect the desirable futures, but also the process side. Then goals in backcasting studies can include the following:

- Generation of normative options for the future and putting these on the agenda of relevant arenas;
- 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 must be noted that specific goals can also be more or less relevant in a specific backcasting study or can be achieved in a particular stage.

3.2. Some theoretical considerations

This subsection briefly deals with some theoretical aspects and key mechanisms underpinning the approach of participatory backcasting. The starting point here is that our societies are socially shaped, which implies 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.

3.2.1. Future visions

It is important to realise that future visions in backcasting are not only analytical constructs, but also social constructs. It has, for instance, been shown that visions are important in technology development as guiding images that are endorsed by actors. In Germany this has led to a body of literature on *leitbilder* (in analogy with *leitmotiv*) in technology studies. For instance, Grin and Grunwald [47, p. 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 if it is possible to provide some orientation to long-term development in a way that it contributes to meeting challenges like the need for sustainability, while avoiding the risk of authoritarian blueprints and ensuring public legitimacy. Their preliminary answer is in fact positive. They distinguish two main features of visions [47, p. 11]. First, mental images of attainable futures are shaped by a collection of actors. Second, these guide the actions of and the interactions between these actors (see also [4]). In addition, visions may have the potential for dealing with problems, for which there are no rules or institutions available [34,48]. Sustainability problems are, again, good examples.

3.2.2. 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, see Brown et al. [49]. 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 actors with different mental frameworks or action theories [50]. The assumption here is that higher-order learning leads to changes in the mind sets or frameworks and thus broadens the space for actions and behavioural alternatives.

4. Case I: Novel Protein Foods at the STD programme

4.1. Background of the STD programme

Early in the 1990s the governmental programme for STD was initiated in the Netherlands with the aim of exploring system innovations towards sustainability and of

identifying opportunities and possibilities for developing sustainable technologies. The STD programme ran from 1993 to 2001. Taking the factor 20 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 [3]. These future visions were analysed with reference to sustainable solutions with the potential to meet the factor challenge, which were elaborated in projects.

Examples of factor 20 projects at the STD programme included fuel cells for boats [3,51], urban underground freight transport, novel protein foods (NPFs) as vegetable meat substitutes [3,52], sustainable multiple land use in which function integration and reduction environmental burden in rural areas were combined, sustainable urban renewal in the city of Rotterdam, C1-chemistry based on biomass and sustainable municipal water systems [3]. The projects at the STD programme included radical technological innovations that met the factor challenge, but also the identification and cultural and structural conditions for development and implementation.

The STD programme has been considered successful in identifying alternative solutions with the potential for considerable environmental reduction factor and developing follow-up agendas and strategic research programmes, though the programme did not succeed in establishing significant follow-up in all projects.

4.2. Approach

Weaver et al. [3, p.76] described the backcasting approach of 7 steps as depicted in Fig. 1. Steps 1–3 are meant for developing a 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 alternative solutions for sustainable need fulfilment. Steps 4 and 5 are 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. Steps 6 and 7 deal with implementation and realising the action agenda and plan. The intention was that stakeholders involved in the backcasting projects would set up co-operations enabling implementation of research and follow-up agendas. The STD programme facilitated this as far as possible. The 7step approach applied at the STD programme agrees very well with the approach of five stages described earlier.

4.3. Novel protein foods project

NPFs emerged during the STD programme as a sustainable alternative for present meat consumption and production with the potential to meet the factor 20 challenge. A project was initiated to elaborate this option, which was co-financed by major Dutch food companies. The project included technology analysis, consumer research, economic analyses and life cycle assessments. During the project a more detailed future vision was developed. This future vision assumed that NPF would substitute 40% of meat consumption in 2035. Looking from a backcasting perspective, this implied that food technology had to be improved considerably, enabling the production of protein foods

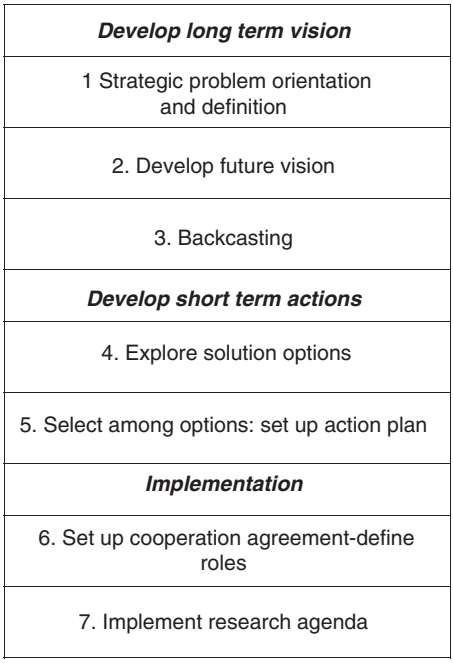

Fig. 1. The STD backcasting approach.

superior in taste and structure compared to meat substitutes. It also implied cultural changes related to the role and status of meat and of novel protein foods. In addition, it also implied structural changes, as the meat sector would decrease and new protein food chains would emerge.

The NPF project involved different forms of stakeholder participation. Research was done by research groups from 7 universities and institutes, involving more than 20 researchers. A different form of involvement was achieved through funding by companies and ministries. These organisations were also represented on the advisory board of the project, which was extended with key persons from research and public interest groups. Furthermore, a dialogue method from the field of CTA entitled 'Future Visions for Consumers' [53] was applied, which gathered a broader group of stakeholders for discussing intermediate results, social aspects, opportunities and constraints. In addition, communication and face-to-face meetings with stakeholders by the project manager and the project team took regularly place.

When completing the project in 1996, it was concluded that these new protein foods could be produced 10–30 times more environmentally efficiently compared to production of pork meat at that time [3,52]. It was also concluded that NPFs could be attractive to both consumers and producers, while socio-economic effects would remain relatively limited when compared to the autonomous development. In addition, it was concluded that the development and large-scale introduction of NPFs in the future would be possible, but that new knowledge, research and development would be required. Results included an analysis of a set of different NPFs (with respect to consumer acceptance and benefits, environmental impact, production costs and socio-economic effects and opportunities),

Table 1
Action agenda for development and introduction of Novel Protein Foods

1.	Communication with the public and supply of adequate information.
2.	Professional education and transfer of new knowledge.
3.	Consumer research and development of appropriate marketing instruments.
4.	Fundamental research on Novel Protein Foods and chain organisation.
5.	Novel Protein Foods product development.
6.	Improvement of possible environmental reduction and development instruments.
7.	Regulation and social measures.

R&D-programmes to develop lacking fundamental and applied knowledge, and a development trajectory towards 2040 consisting of activities for both the short-term and the long-term. After the analysis a development trajectory was elaborated for which 7 clusters of follow-up activities were identified (see Table 1). The listed clusters of activities in Table 1 can be seen as a policy and action agenda for sustainable technological development around the option of NPF.

4.4. Follow-up and impacts

It is interesting to comment on the extent to which follow-up has been accomplished (see also [54]. Interestingly, there is considerable follow-up. First of all, a huge research project (entitled Profetas, www.profetas.nl, see also [55]) has been carried out, dealing both with the technological issues and the socio-economic and cultural issues 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. Furthermore, NPFs have been discussed occasionally by a major supermarket chain, while NPF and meat substitutes have been incorporated in the sustainable food consumption activities of the ministry of the Environment.

5. Case II: Nutrition case study in the SusHouse project

5.1. Background of the SusHouse project

The EU-funded SusHouse 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, taking both consumption and its interconnection with production through products and product usage into account [4,5,30]. 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) nutrition, each in three different countries. An account of the overall methodology and the overall results from the 9 case studies has been given earlier in this journal by Green and Vergragt [5]. We focus here much more in-depth on a particular case study, which is the sustainable household nutrition case study in the Netherlands [56]. Furthermore, we include the issue of follow-up and implementation.

5.2. Approach

The approach was, briefly, as follows. For each household function studied in each country, a *stakeholder analysis* 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* aiming to identify sustainable ways of future function fulfilment. The results were used for *scenario construction*. These normative scenarios were assessed in terms of environmental gain, consumer acceptance and economic credibility, and 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. In both series of workshops *backcasting techniques* were applied, while backcasting was also done during scenario construction by the research teams involved. The approach was split into 7 steps as shown in Fig. 2, which are discussed in [4,5], while stakeholder involvement and stakeholder workshops are discussed in a more detailed way in [31]. Finally, the 7 steps fit into the framework of 5 stages as proposed in Section 3.1.

5.3. Nutrition case study in the Netherlands

Scenario construction for nutrition in the Netherlands was based on the results of a stakeholder creativity workshop gathering a wide range of stakeholders and the Design Orienting Scenario (DOS) methodology of Jegou and Manzini [57] and its elaboration

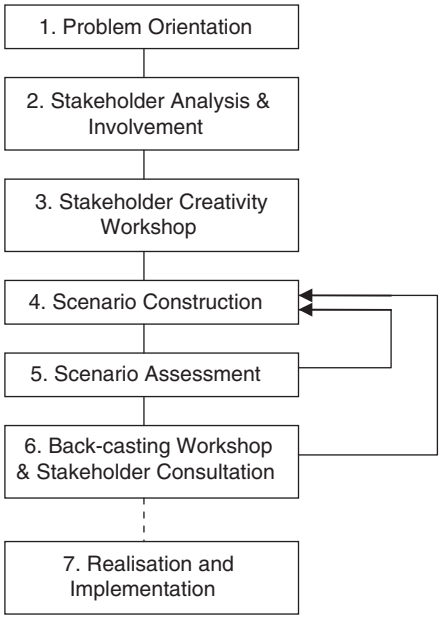

Fig. 2. The steps in the SusHouse backcasting approach.

Table 2
Brief descriptions of the three nutrition scenarios

Intelligent Cooking and Storing (ICS) is about a household characterised by high-tech, convenience, do-it-yourself and a fast lifestyle. 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 foods replacing meat) or ready-made meals containing a microchip communicating cooking instructions with the microwave oven.
Super-Rant (SR) combines elements from the present supermarket and restaurant 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.

given in [58]. DOS-type scenarios contain a vision, main characteristics, story boards and a backcasting analysis. Table 2 summarises the constructed household nutrition scenarios. More detailed results can be found elsewhere [56].

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 direct everyone towards the most sustainable scenario.

Three scenario assessments were conducted alongside the backcasting analysis. 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 credibility. 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 and Storing scenario and the Local and 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 might 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 [56].

Scenarios and assessment results were fed into a second stakeholder workshop focusing 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.

5.4. Follow-up and impacts

During the second workshop there was considerable interest from stakeholders for co-operation around concrete proposals and activities. A number of initiatives were started,

leading to concrete co-operation between stakeholders around ideas and proposals. However, it proved hard to get these funded.

These initiatives included a workshop focusing on domestic appliances for treating NPF at home, which was organised jointly by a research body and a company. 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, together with other stakeholders from different societal groups. The Dutch research group originally involved in the SusHouse project also developed a programme proposal for a transition towards sustainability in eating-out and the food-service sector [59,60]. Scenarios and other results were also used in a related project also dealing with sustainable food consumption, which also led to a joint workshop and related activities [61].

6. Conclusions

This paper has presented backcasting as a promising, strategic and innovative participatory foresighting approach for sustainability based on stakeholder involvement, construction of normative sustainable futures, stakeholder learning and combining participatory, design and analytical activities. The essence consists of generating desirable sustainable future visions and turning these, through backcasting analysis, design activities and analysis, into follow-up agendas, planning for actions and realising follow-up activities. This clearly makes backcasting more than looking back from the future, while the focus on normative scenarios or future visions, implementation and follow-up distinguishes it from most foresighting and scenario approaches.

Backcasting originates from the 1970s and was originally developed as an alternative for traditional forecasting and planning. The original focus was on policy analysis for energy planning and later on exploring sustainable futures and solutions, while stakeholder participation and achieving implementation became important in the last decade. Furthermore, it can be applied on the level of organisations, regions, industrial sectors, socio-technical systems, countries and on a global scale. However, backcasting is not the only approach using normative or desirable future visions. It is possible to position backcasting approaches in a family of approaches using normative scenarios and stakeholder participation. For instance, Rotmans et al. [62] report on normative scenarios for sustainable areas in Europe in which stakeholders were involved, while Street [63] reports on the use of scenario workshops as a participatory approach to sustainable urban living and Raskin et al. [64] (2002) report on work of the Global Scenario Group led by the Tellus Institute, which has resulted in a set of normative global scenarios and the strategies for achieving a sustainable one. However, how these examples exactly relate to backcasting would require further study.

It has also been found that backcasting can refer to a concept or philosophy, a study, an approach, a methodology, an interaction process among participating stakeholders, an analysis (sometimes referred to as a *backcast*) or the specific step of looking back from the desired future within the overall approach. This means that backcasting is used to refer to 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 to the level of specific steps, methods or instruments within such an overall approach or overall methodology. However, it also shows that backcasting is

slightly differently defined in different places and reports, which might be confusing in the present debate and when comparing different backcasting studies.

In this paper, we have proposed a methodological framework for participatory backcasting, which may clarify some of this confusion. This framework consists of 5 stages and the outline of a toolkit containing four groups of methods and tools: design tools, participatory tools, analytical tools and management, co-ordination and communication tools. It is important to realise that the backcasting approach is not only multi-disciplinary, but also trans-disciplinary. In addition, different type of goals can be distinguished regarding the future vision and its requirements, the stakeholder process and the analytical results.

It can be concluded from the two case studies that participatory backcasting projects have succeeded in stakeholder involvement, future visions, analytical results, while also delivering follow-up agendas and implementation plans. The two cases demonstrate that backcasting can be a powerful tool for developing alternative sustainable future visions utilising the expertise and knowledge of a broad range of stakeholders. In addition backcasting analysis, further elaboration of attractive clusters and ideas and additional assessments can lead to definition of follow-up agendas containing R&D-activities, other activities concerning implementation, strategy development, policy recommendations and short-term proposals attractive for specific stakeholders or stakeholder alliances.

The two cases show considerable differences with respect to impact and follow-up. The Novel Protein Food case shows considerable follow-up, while the SusHouse nutrition case shows follow-up attempts, but no lasting efforts. The question now arising is what the explanation for this difference between the two cases could be. Both were successful in involving stakeholders and in constructing, elaborating and analysing sustainable solutions for future need and function fulfilment. Both also led to follow-up agendas and ideas for implementation and activities, but only in case of the Novel Protein Foods was considerable follow-up and implementation. Further evaluation of completed backcasting experiments and backcasting practices is necessary to enhance our knowledge about this and to improve our understanding of the factors enabling and constraining this. This will enable developing recommendations, guidelines and conditions for backcasting projects and increasing their effectiveness with respect to follow-up. A research proposal has been proposed for this [48] and is currently being carried out.

However, a broader research agenda is needed. This should not only include the comparison of backcasting studies in different countries including their impacts. Especially, the functions that visions can fulfil (and which not) as images or *leitbilder* guiding implementation and transformation of socio-technical systems needs further investigation. It should also include evaluation of methods and tools that were applied within a backcasting framework enabling to extend the suggested toolkit. Furthermore, comparisons are needed between backcasting approaches and related approaches that use normative future visions like Transition Management [2], the Tellus approach [64] and participatory approaches aiming to achieve system shifts towards sustainability like Strategic Niche Management [65]. Finally, new participatory backcasting studies must be undertaken and also thoroughly evaluated, for instance industrial ecosystems seem an interesting field of application.

Execution of this research agenda will enhance the potential of backcasting for sustainable system innovations as an approach for identifying, exploring and initiating this type of radical changes on a system level reconciling the development of existing systems

with sustainable development. A further elaboration of the toolkit for backcasting will support this. Then it will become also very relevant that not only knowledge is generated in the academic realm, but that transfer takes place to professionals working in the practice of sustainable system innovations employed by governments, the private sector and others. Though participatory backcasting can be characterised as a complex and complicated approach, it is very well possible to teach it in higher education [66].

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