

Does backcasting lead to system innovations to sustainability? The case of meat alternatives and novel protein foods

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Abstract

Backcasting: looking back from a desirable future that has been generated first. Since the early 1990s sustainable futures have been explored in backcasting experiments, numerous stakeholders have been involved and steps have been planned in line with the envisioned sustainable futures. But what is the impact of these so-called backcasting experiments ten years later? So far, systematic case studies evaluating backcasting studies after a couple of years and comparing these have hardly been done.

The aim of this paper is to evaluate the impact of a backcasting experiment after 10 years using the Novel Protein Foods (NPF) and meat alternatives as an example. This backcasting experiment in the Netherlands was completed in 1996. It focused on vegetable protein foods as a future sustainable alternative for meat, while also aiming at follow-up and implementation. But has it led to socio-ecological change or to a system innovation towards sustainability?

The paper develops a framework to conceptualise and analyse the impact of backcasting experiments. The framework elaborates and builds on the industrial network concept, the Leitbild concept from German sociology of technology, and uses the concepts of institutionalisation and institutional resistance. Next, it describes and analyses NPF related activities and dynamics in the Netherlands in four domains: (1) research, (2) business, (3) policy, (4) public and public interest. Results are evaluated in terms of networks, Leitbild characteristics, how these mutually influence each other and how this relates to the governance issues.

It is concluded that the effects in the four domains can be summarised as from 'nothing to niches' and can also be seen as a potential seed for a system innovation towards sustainability. Conclusions are related to the Multi-Level Perspective (niche-regime-landscape) and governance aspects are discussed.

Keywords

backcasting; novel protein foods; meat alternatives; sustainability; networks; institutionalisation; Leitbild/ future vision, governance

1. Introduction

Contemporary societies face the challenge of realising sustainable development and have to deal with underlying complex sustainability problems and related socio-ecological change. Sustainable development demands that the needs of the present generation be fulfilled in such a way that future generations will also be able to meet their needs (WCED 1987). This requires interrelated technological, cultural, organisational and institutional changes at the level of socio-technical systems, such as related production and consumption systems, industrial sectors, household consumption domains like mobility and shelter, geographical regions and cities. This type of system changes is being referred to as transitions (Geels 2005, Rotmans *et al.* 2001), system innovations (Elzen *et al.* 2004, Quist and Vergragt 2006), industrial transformations (Olsthoorn and Wieczorek 2006), whereas others refer to socio-ecological change¹. Although these terms and concepts cover basically similar phenomena, in this paper the term system innovation to(wards) sustainability is used. It is defined here as the transformation from one socio-technical system towards another, sustainable one. Furthermore, system innovations take several decades and require the involvement of many actors. These actors possess relevant expertise and resources to contribute to system innovations towards sustainability. They are also needed because they can provide legitimacy and support with regard to the changes associated with the system innovation.

It has been widely shown that participatory backcasting is an excellent approach to explore system innovations towards sustainability, as well as to define and initiate first steps towards an envisaged system innovation (e.g. Quist 2007, Quist and Vergragt 2006, Vergragt 2005). Backcasting has considerable potential to identify, to explore and to initiate trajectories towards such transformations of socio-technical systems. Backcasting means literally looking back from the future (and it can be seen as the opposite of forecasting which means looking to the future from the present). According to Dreborg (1996) backcasting is particularly useful if it concerns highly complex problems, when there is a need for a major change, when dominant trends are part of the problem, and when scope and time-horizon are wide enough to leave room for very different alternatives and implementing these. Socio-ecological change and most sustainability problems are clear examples of this type of problems.

Backcasting was proposed in the 1970s in energy studies (e.g. Lovins 1977) and later also applied to sustainability planning (e.g. Robinson 1990) and to sustainable organisations (Holmberg 1998). Since the early 1990s it has developed into a participatory approach, especially in the Netherlands (Quist and Vergragt (2004, 2006) and Canada (Robinson 2003), the former also focussing on implementation and generating follow-up activities that contribute to bringing about the generated desirable sustainable futures. In the Netherlands participatory backcasting was for instance applied at the Sustainable Technology Development Programme (Weaver *et al.* 2000), the 'Strategies towards the Sustainable Household (SusHouse)' (Quist *et al.* 2001, Green and Vergragt 2002), the COOL project dealing with options preventing climate change (Van de Kerkhof 2004), sustainable industrial paint chains (Partidario 2002), livestock breeding research (Grin *et al.* 2004) and in education (Quist *et al.* 2006).

However, we know rather little about the impact of participatory backcasting after five to ten years, as systematic case studies evaluating the long-term effects of backcasting experiments ten years later and comparing cases have hardly been done so far. Nevertheless, we do know that backcasting experiments show considerable differences in achieving follow-up and broader effects after a few years (Quist *et al.* 2005). Investigating the impact of backcasting experiments after five to ten years may thus shed more light on what

¹ In this conference socio-ecological change is described as leading to overarching global sustainability problems like climate change and loss of biodiversity and ecosystem services. By contrast, I would like to argue that sustainable development can be seen as an example of socio-ecological change too, but then dealing with or solving sustainability problems and contributing to sustainable development.

factors determine follow-up and impacts long before the desired future vision will be reached. As a consequence the aim of this paper is to evaluate the impact of a particular backcasting experiment on Novel Protein Foods (NPF) and meat alternatives after 10 years. This backcasting experiment was conducted at the Sustainable Technology Development (STD) programme in the Netherlands between 1993 and 1996. It dealt with vegetable protein foods as a future sustainable alternative for meat, while also aiming at follow-up and spin-off.

But has this backcasting experiment led to reduced environmental burden and other effects after ten years that may possible lead to a system innovation towards sustainability? This question is the major focus of this paper, which is organised as follows. First, the paper develops a framework to conceptualise and analyse the impact of backcasting experiments after five to ten years (Section 2). The framework elaborates and builds on the industrial network concept, the Leitbild concept from German sociology of technology, and uses the concepts of institutionalisation and institutional resistance that are rooted in institutional theory. Next, Section 3 describes and analyses the NPF backcasting experiment that took place between 1993 and 1996 in the Netherlands. Section 4 analyses NPF-related follow-up and spin-off in the Netherlands in terms of networks, visions and institutional change covering four societal domains. Finally, Section 5 draws some conclusions, whereas Section 6 discusses system innovation aspects and addresses some implications for governance.

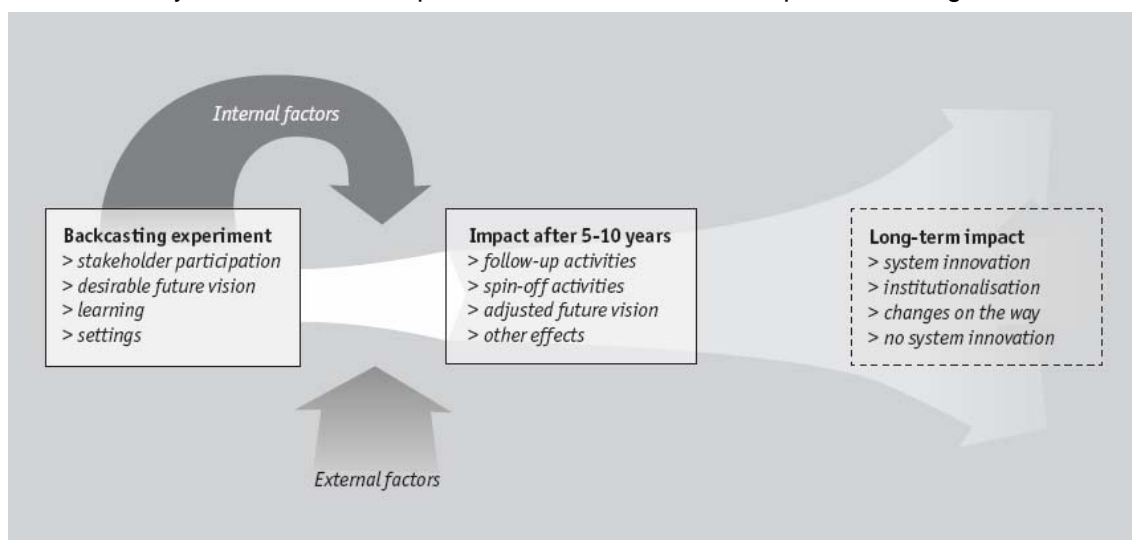


Figure 1 The backcasting experiment, the impact after 5-10 years and long-term impact

2. A framework to evaluate the impact of backcasting experiments

2.1 Introducing the framework

A backcasting experiment is defined in this paper as the activity or various related activities, in which backcasting is applied explicitly and in which a range of stakeholders is involved. A backcasting experiment thus always includes stakeholder participation. If there is no stakeholder involvement, the term backcasting study is preferred. A backcasting experiment may consist of a single project, but also of several successive or parallel projects. Figure 1 shows the three main phases that can be distinguished when a system innovation grows out of a backcasting experiment. This is a simplification, as system innovations are very unlikely to result from a single backcasting experiment alone, and many other actors and factors will be at play as well. These three phases are:

- The first phase consists of the backcasting experiment, reflected by the box on the left, which lasts approximately one to three years.

- The second phase consists of the impact after five to ten years after completion of the backcasting experiment, which is shown by the box in the middle.
- The third phase consists of the long-term impact after 40 to 50 years, which is depicted by the box on the right, and which is also the time horizon of the system innovation towards sustainability envisaged in the backcasting experiment. This is not a static end-state but a dynamic one in which all kind of (change) processes will continue to take place. These dynamics may lead to adaptations or adjustments within the addressed system, or even lead to changes at the level of system innovations. It is thus very unlikely that the long-term effects (fully) match with the desirable future envisioned in the backcasting experiment.

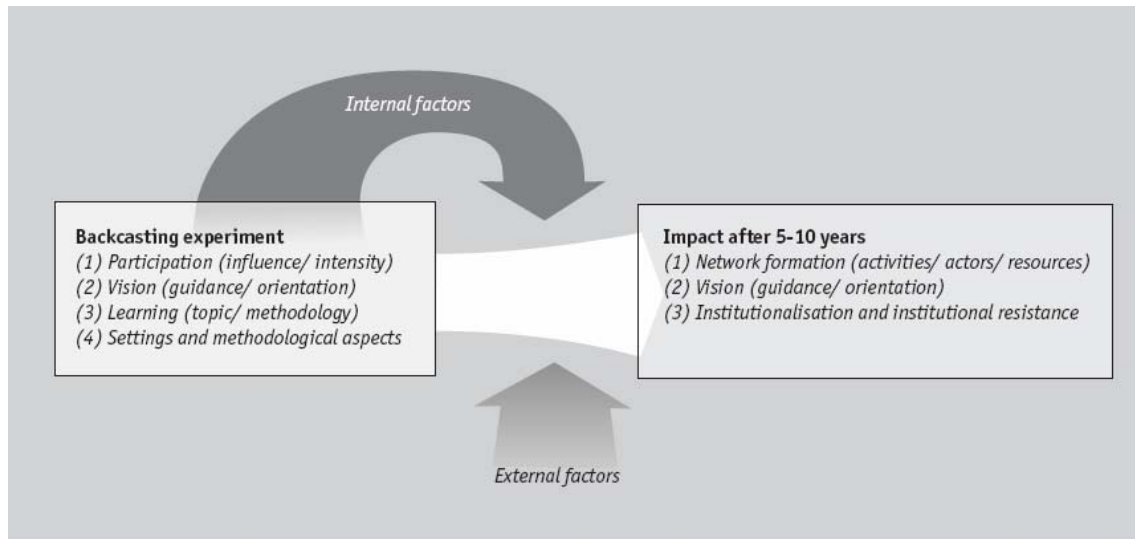


Figure 2 The backcasting experiment and its impact after five to ten years

Figure 2 gives a more detailed view on the backcasting experiment and its follow-up and spin-off after 5 to 10 years. It also shows various elements in both phases, which are considered important for developing a conceptual framework. The following findings (Quist 2007) are derived from a literature review and are used for developing the framework:

- Broad stakeholder participation can help increase legitimacy and accountability, structure complex unstructured problems like sustainability problems, broaden issues with a range of aspects and values and increase support and involvement (also in follow-up).
- New emerging future visions can become guiding images shared by groups of stakeholders that provide guidance and orientation to the supporting stakeholders in line with the future vision in a process of diffusion and further elaboration of the vision.
- Emerging visions face competition from other emerging visions and their supporters, as well as from the regular dominant vision supported by vested interests and actors.
- Visions may have strong normative and ethical assumptions and be generated deliberately by groups of stakeholders.
- (Higher order) learning may encourage actors to reformulate problem definitions and shift their preferred ways and approaches to dealing with a certain problem. Increased insight into the values and views of other stakeholders may be another result.
- Both the way the backcasting has been applied and the organisational settings of the backcasting experiment, are likely to affect the nature and degree of follow-up.
- Network theories provide a promising way for analysing follow-up and spin-off activities.
- Successful networks around follow-up and spin-off activities may lead to instances of institutionalisation in which institutions change, as well as to instances of institutional resistance from vested interests and backing actors who feel threatened.

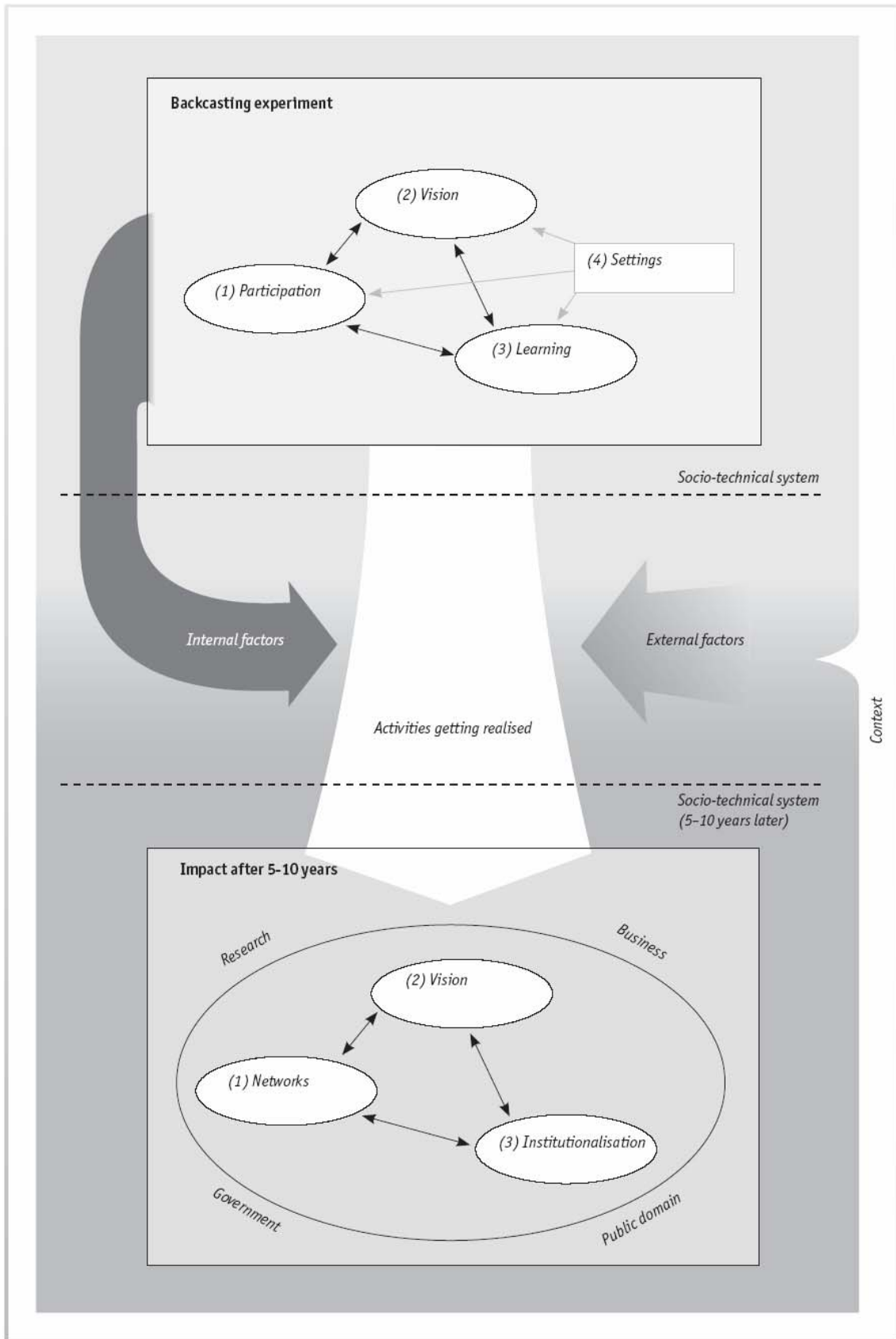


Figure 3 The conceptual framework for the backcasting experiment and its impact

The proposed conceptual framework as shown in Figure 3 comprises thus (i) the backcasting experiment and (ii) the follow-up and spin-off after five to ten years. The backcasting experiment addresses the sustainability problems that cannot be solved through incremental changes. The socio-technical system in which both phases occur can be defined differently, depending on the sustainability problem(s) targeted; it can be a production and consumption system, an entire geographical region, or an industry. Both phases are conceptualised by building blocks that are described below (Quist 2007).

The backcasting experiment phase consists of four building blocks: (1) stakeholder participation, (2) future visions, (3) learning, and (4) settings and methodological aspects. The building blocks are based on various theories about actor and stakeholder participation, the *Leitbild* concept from German sociology of technology, theories about higher order learning and the methodological framework for backcasting, respectively. The building block **participation** includes various aspects derived from a number of actor and stakeholder participation theories, including stakeholder heterogeneity, stakeholder influence and the degree of involvement. The building block **future visions** includes the aspects 'guidance' (where to go) and 'orientation' (what to do), which are derived from the *Leitbild* concept, while the aspect 'competing visions' has been added. The building block **learning** emphasises higher order learning by actors and includes shifts in problem definitions, perceived solutions and principal approaches to dealing with the problems at the level of individual actors, as well as joint and congruent learning at the level of groups of stakeholders. Whereas joint learning refers to consensus and joint opinions, congruent learning reflects non-conflicting issues. The building block on **settings and methodological aspects** comprises various aspects reflecting how the participatory backcasting approach has been applied, as well as settings.

The follow-up and spin-off phase consists of three building blocks: (1) network formation, (2) future visions (3) institutionalisation. The building block **network formation** is based on industrial network theory and contains the aspects 'activities', 'actors' and 'resources'. Like in the phase of the backcasting experiment the building block **future visions** comprises the aspects 'guidance', 'orientation' and 'competing visions' in the same way as in the phase of the backcasting experiment. The building block **institutionalisation** uses institutional theory. The aspect 'institutionalisation' reflects changes in institutions and rules, whereas the aspect 'institutional resistance' reflects resistance from vested interests and institutions and the actors backing them.

The conceptual framework also proposes **internal factors** and **external factors** that both exert influence on the emergence of follow-up and spin-off. Internal factors are characteristics of the backcasting experiment. External factors are exerted by the socio-technical system and its context, which surround the backcasting experiment and its follow-up and spin-off. The socio-technical system 'enters' the backcasting experiment through the participating stakeholders, but at the same time the backcasting experiment is to some extent an organised, albeit rather isolated space for experimentation within the socio-technical system. The context of the socio-technical system consists of other sectors and socio-technical systems in the Netherlands, as well as abroad. Internal factors and external factors can have both a positive (enabling) and a negative (constraining) influence on follow-up and spin-off. Four domains are distinguished in which follow-up and spin-off may occur: (1) research, (2) business, (3) government, and (4) the public domain that includes public interest groups as well as the wider public.

Finally, the broad arrow in Figure 3, which connects the backcasting experiment and the follow-up and spin-off after five to ten years, depicts the process in which stakeholders are attracted to the future vision and the agenda generated in the backcasting experiment, and start turning them into action and activities that result in 'spin-off and follow-up'.

2.2 Discussing building blocks on learning, visions, networks & institutional change

Whereas building blocks and on stakeholder involvement and methodological settings are rather straight forward and less interesting from the viewpoint of this conference, it seems interesting to explain a bit more about building blocks on learning, visions, networks & institutional change.

Future visions

The Leitbild concept of Dierkes *et al.* (1992, 1996) combines several interesting characteristics with a firm theoretical foundation. It has two main characteristics:

- (1) The vision is shared and helps unite people and actors from different backgrounds, and;
- (2) The vision guides the behaviour and actions of actors who share or support the vision.

A future vision, which is used instead of Leitbild here, is an emergent phenomenon that provides guidance and orientation. **Guidance** reflects 'where to go' and **orientation** reflects 'what to do', which are used as two aspects in this building block. In line with Dierkes *et al.* **guidance** consists of a (i) collective normative projection or image, (ii) synchronisation among all stakeholders involved and (iii) presence of alternative (systems of) rules that do not yet exist. Assuming that the future vision concept can be used broader than Dierkes *et al.* (1992, 1996) have done for technical novelty, I argue that the future vision concept can also be used for sustainable socio-technical alternatives and that it may have an explicit normative or ethical component, as has also been suggested by Grin (2000). It is also proposed here that the new visions for alternative future socio-technical system options emerge at the crossroads of various societal domains and various scientific disciplines. This assumes broadening the idea of synchronisation between different scientific disciplines, as proposed by Dierkes *et al.* (1992, 1996). In the framework developed here synchronisation and alignment are thus not limited to representatives of different scientific disciplines, but apply to all the stakeholders from the various societal domains. Next, **orientation** of the future vision consists of (i) cognitive activation, (ii) mobilisation of actors and resources, and (iii) decentralised daily coordination among the stakeholders involved. In comparison to Dierkes *et al.* here the actor level is emphasised and the individual level is less focused on.

The third aspect I want to add in this building block are **competing visions**, which includes both the dominant vision and alternative visions that may emerge. This is in line with Grin (2000), who has pointed to the influence of existing dominant visions in existing sectors and socio-technical systems, which reflect the vested interests. For the emerging alternative and competing visions I use the idea that each vision can be seen as an emerging future socio-technical scenario (see e.g. Callon 1987, Callon 1995, De Laat 1996, De Laat and Larédo 1998). Particular socio-technical scenarios have been agreed on by involved actors, while competition takes place between various future socio-technical scenarios and their supporting actors. This is also in line with Berkhout (2006) and Smith *et al.* (2005) who emphasise the competition between visions and their supporting actors and networks in processes of coordination and the formation of coalitions.

Stakeholder learning

The building block stakeholder learning focuses on higher order learning (also called double-loop learning, second-order learning and collective value learning, for more detailed overviews see Brown *et al.* 2003 or Quist 2007). Higher order learning leads to changes in the frames of actors and thus increases the space for actions and behavioural alternatives and allows for the formation of alliances or cooperation with other stakeholders. Higher order learning is also about actors who change problem definitions and perceived solutions, shift preferred ways and approaches how to deal with the problem and the extent to which these changes and shifts are shared among the participants (Brown *et al.* 2003). It can be on the content, the process as well as on the backcasting approach.

This building block uses the conceptualisation of higher-order learning as proposed by Brown *et al.* (2003). This concept combines various relevant characteristics from a range of theories

on higher order learning and has proven to be applicable in temporary project-like settings dealing with innovations. Brown *et al.* (2003: 296) have defined learning as “*consisting of three interrelated shifts: (1) a shift in the framing of the problem and of the perceived solution (or a menu of solutions); (2) a shift in the principal approaches to solving the problem, and in the weighing of choices between desirable yet competing objectives; (3) a shift in the relationship among the participants in the experiment, including mutual convergence of goals and problem definitions.*” The three types of shifts are the aspects that make up this building block. The first and second types of shifts occur at the level of particular actors. The third type emphasises mutual convergence and congruence, and reflects learning at the level of a group of actors; it is called **joint and congruent learning**. Please note that if divergence of opinions occurs with a group this can also be seen as learning, but is considered to occur at the level of individual actors, thus to be part of the first or the second type of shift. It is also possible for two processes of convergence to take place among two groups of actors, leading to divergence of goals and problem definitions. Then two groups emerge that can be phrased in line with Sabatier and Jenkins-Smith (1999) as two different advocacy coalitions.

Network formation

Network concepts and theories provide a useful way for describing and analysing the follow-up and spin-off of backcasting experiments after five to ten years. Following Håkansson’s (1987, 1989) industrial network theory I conceptualise networks as webs of relationships reflected by three aspects: (i) **activities**, (ii) **actors**, and (iii) **resources**. Relationships exist not only between actors; Håkansson also distinguishes relationships between activities, which he calls activity links, as well as between resources, which he calls resource ties. The three aspects are related as follows:

- Activities are conducted and established by actors;
- Actors mobilise different types of resources;
- Resources are heterogeneous and needed to perform activities or have them performed;
- Mobilising resources and conducting activities requires relationships and cooperation with other actors, while different types of relationships are possible;
- Activities, actors and resources make up a network;
- Activities reflect relationships between actors.

Various adjustments to Håkansson’s network theory are needed as part of the conceptualisation of the network building block. Unlike Håkansson, it does not start with a focal company or group of companies, but instead the focal activity is introduced as a starting point for determining the network, the actors involved and the resources mobilised for the activity. Phenomena such as a research programme, an industrial R&D project, and the development or implementation of a policy programme can be seen all as activities. Next, it is assumed that such activities can take place in all four societal domains that have been distinguished: the research domain, the business domain, the government domain and the public domain. Activities are thus not limited to the business domain, on which Håkansson focuses, but can transcend domain boundaries and may involve actors from different domains. Finally, the relationships between the actors involved can take different forms; relationships can be both informal and formalised. Examples of the latter include contracts, written agreements, jointly submitted proposals, assignments, etc.

Institutional change

This building block is conceptualised by two aspects, which are based on institutional theory (e.g. Scott 2001, or Van de Hoed 2004, for applying it to developments in fuel cell vehicles). Institutions are defined here as rules, which can be regulatory, cognitive and normative (Scott 2001). The aspects defined here are **institutionalisation** and its counterforce **institutional resistance**. The definition of institutionalisation by Oliver (1996: 166) serves as

a starting point: “*the process by which a practice becomes socially accepted as ‘right’ or ‘proper’, or comes to be viewed as the only conceivable reality*”. Institutionalisation is used here as an aspect for covering the wider and broader effects and entrenchment of follow-up (activities) and spin-off. In particular, the focus of this aspect is on changes in institutions in the sense of rules, thus focussing on institutional change. However, as institutionalisation requires change processes of rules and institutions, there will be resistance due to existing interests, customs and institutions. Therefore, the second aspect ‘institutional resistance’ is defined as the resistance to change by existing institutions and the actors backing them.

2.3 Methodology

An empirical ex-post case study approach has been applied to investigate the NPF and meat alternatives case. According to Yin (1994: 14) a case study can be defined as an empirical inquiry that investigates a contemporary phenomenon, especially useful when the boundaries between the phenomenon under study and the context are not clearly evident. It also allows the in-depth identification of a large range of variables, while Yin (1994) also recommends including external factors and using a multitude of sources. The latter helps realise a more complete picture of cases and allows data to be validated more convincingly.

The case study reported on was studied through: (i) through the use of (internal) documents and reports from the backcasting experiment and included various internet sources; (ii) the use of (internal) documents and reports from follow-up activities and other spin-offs including internet sources; (iii) twelve semi-structured in-depth *interviews* involving thirteen persons (mostly face-to-face, sometimes by telephone) with key persons covering the four domains, as well as numerous briefer telephonic contacts. Interviewees had been involved in either the backcasting experiment, or in follow-up (attempts) and spin-off. Three interviewees had been involved in both phases, whereas several interviewees represented organisations that had been involved in the other phase through other individuals. A more detailed description of case and analyses can be found elsewhere (Quist 2007).

3. The Novel Protein Foods backcasting experiment

3.1 Process and outcomes

Early in the 1990s the governmental programme for Sustainable Technological Development (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 using backcasting and future visions. The STD programme ran from 1993 until 2001. Novel Protein Foods (NPFs) emerged during the start-up of the STD programme as a sustainable alternative for present meat consumption and production with the potential to meet the Factor 20 environmental improvement challenge in the future (Jansen and Vergragt 1992). First activities were initiated early in 1993 to elaborate this option: a range of interviews with business R&D representatives and scientific experts, followed by a feasibility study conducted by an international research consultancy firm.

The next stage of the backcasting experiment consisted of a research and stakeholder involvement project of several Millions of Euros, which was funded by three Ministries and co-financed by major Dutch food companies. This so-called Novel Protein Foods 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 Novel Protein Foods 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 superior in taste and structure compared to present 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 Novel Protein Foods project involved various forms of stakeholder participation. Research was done by research groups from seven universities and institutes, involving more than 20 researchers. A different type 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 stakeholder dialogue method from the field of Constructive Technology Assessment entitled 'Future Images for Consumers' (Fonk 1994) 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 (Weaver *et al.* 2000, STD 1996). NPFs could be attractive to both consumers and producers, while socio-economic effects would remain relatively limited when compared to the autonomous development. The development and large-scale introduction of NPFs in the future would be possible but new knowledge, research and development would be required. 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 consisting of activities for both the short-term and the long-term that made up a follow-up action and policy agenda. This follow-up agenda included R&D-activities, product development activities, policy recommendations, awareness raising, education, knowledge diffusion and communication with the public.

3.2 Analysis

Table 1 summarises various aspects of **stakeholder participation**. About 100 to 150 individuals were involved during the three years that the backcasting experiment took place, which agrees with 50-60 stakeholder organisations. Due to communication activities, many more persons and organisations were informed about the topic and results. The stakeholder heterogeneity was high, which meant in this case that all four societal domains were represented in the backcasting experiment. The degree of involvement varied strongly. Contracted researchers and staff from the STD programme that made up the NPF project team were intensively involved, whereas the degree of involvement of most individuals and stakeholders was low, yet sometimes of a strategic nature with high-level individuals. The types of involvement by stakeholders outside the government included funding, capacity, knowledge and support. The degree of stakeholder influence on the process was low, as it was fully done by the STD staff. Interestingly, the degree of influence on the content was also relatively low, although a small group of business R&D people and scientific experts that were consulted in the early stages had a high influence on defining and bounding the topic. As a result the business innovation perspective was emphasised: NPFs were defined as novel innovative protein foods that could be more attractive to consumers than meat and not as a problem of targeting meat consumption or targeting livestock breeding directly.

Table 1 Stakeholder participation in the three backcasting experiments

	<i>NPF case</i>
- Number of individuals	100 - 150
- Number of stakeholders	50 - 60
- Heterogeneity	High
- Degree of involvement	Varying
- Type of involvement	Funding & capacity
- Degree of influence (on process)	Low (organisers High)
- Degree of influence (on content)	Low-Moderate; small group High

One future **vision** emerged and evolved during the backcasting experiment, although it was nested. The vision started as an idea during the start-up of the STD programme. It evolved into the vision of a group of people, after which it was further elaborated and eventually quantified and tested. Both the degree of guidance and the degree of orientation were evaluated as high. This meant that the vision provided guidance (where to go) through a collective projection, that synchronisation among stakeholders from different societal domains took place and that alternative rules were present and experimented with in vision and backcasting experiment. With regard to the high degree of orientation (what to do) it meant that substantial cognitive activation took place, as well as mobilisation of stakeholders and resources and decentralised coordination among those involved.

Other future visions were present in the context of the backcasting experiment. For instance, there was the regular dominant vision on meat production and meat consumption supported by the vested interests. The actors backing this vision preferred the status quo and were in favour of improving the 'economic health' of the cattle and meat processing sector, as well as to reduce the emissions of intensive livestock production by improving stables and fodder conversion. These actors paid little attention to the NPF future vision that was nurtured in the backcasting experiment. However, they opposed it when the NPF vision became 'within reach'. In networks of environmentalists and vegetarians other visions were present as well. These visions included eating less meat, more organic meat and reducing meat consumption by targeting and educating consumers as well as decreasing the meat sector by regulation and to increase environmental regulation for intensive livestock production.

Higher order **learning** occurred on the topics under study in the backcasting experiments among stakeholders involved, as well as on the backcasting approach. For instance, joint learning took place with regard to the opportunities for alternative protein foods, which until then were seen as non-existent by major companies and leading food researchers. This concerns a shift in a perceived solution to the problem of meat production and consumption. Joint learning also took place as a result of the TvC stakeholder meetings. The participants issued a final statement that included a list of issues on which agreement was reached, like the relationship with global food security (Fonk and Hamstra 1996: 67-71). This assumes joint learning, or at least as congruence. Both participants and organisers considered the participatory backcasting approach an innovative and attractive novel way of dealing with sustainability problems, which relates to a shift in principal approaches to solving problems (see also Loeber 2004: 187).

4. Follow-up and spin-off after 10 years

4.1 Network formation

In this section NPF-related activities that were identified in interviews and documents are grouped and analysed in terms of network formation. This analysis uses the indicators (1) activities, (2) actors and (3) resources and takes the identified activities as starting points to map the actors involved and the resources mobilised (especially funds). Results are summarised in Table 2 for the four domains distinguished. When actors from more than one domain were involved, the activities are put in the domain where they fit most.

Table 2 shows that in all four domains NPF-related activities could be identified. Compared to the backcasting experiment, the total numbers of actors and individuals, involved in follow-up and spin-off activities has increased (see Table 2), as has the total amount resources that was mobilised for NPF-related activities. In addition, the number of activities has grown considerably, from the NPF backcasting experiment to a range of activities in the four domains distinguished. Most activities also fit in the follow-up agenda proposed at the end of the NPF project, although remarkably enough this is not due to central(ised) coordination. The activities emerged in a decentralised way. Regarding financial resources, the vast

majority of funds originated from public sources, such as institutional academic funding organisations like NWO, MaG and STW, and several ministries.

Table 2 Networks constituting NPF-related activities

Research domain		
Activities	Actors	Resources
Profetas Programme (1999 – 2004)	Three universities (VU, Twente, WUR), Research schools VLAG and SENSE, WCFS; Several research institutes, five companies (Boekos, Cebeco, Quest, DSM, Unilever Research)	Funding by various research councils (NWO board, STW, MaG), the ministry of Agriculture (LNV), WCFS, participating companies, totally around 3 Million Dutch guilders
TNO research programme on the future of protein foods R&D project on mould based protein food ingredients (1997–2001)	TNO Nutrition and various companies TNO Nutrition, DSM Food Specialties (formerly Gist-brocades), Boekos	Funding by TNO, companies, innovation programme funding Funding BTS governmental innovation programme, company investments
WUR strategic research programme (2002-2006)	WUR (former DLO part), WUR research institutes	Internal budgets from the central organisation of DLO (Agricultural Research Division)
Development of programme proposal on sustainable kitchen and food chains (2000)	Boekos, TNO-Kathalys, TU Delft, WUR, Kleine Aarde and various others	Proposal for € 450,000 was submitted to NIDO contest but not approved for funding
Business domain		
Activities	Actors	Resources
Product development of mould-based protein food (ongoing follow-up of the BTS funded R&D project) NPFs and meat alternatives in catering chains (including product development and catering tests)	DSM Food Specialties (formerly Gist-brocades), unknown successor of Boekos Sodexho, Deli XL, Schouten Europe, LEI, KDO Consultancy, test facilities at seven organisations	Company investments Funding by AKK (Agro Chain Knowledge), Novem and companies, totally several million euros for several related projects
Product development at Boekos Workshop, proposal on development domestic appliances for NPFs (2000) R&D projects on extracting proteins from lucerne and grass (1997-2002) Development and market introduction of Valess (2005) Establishment of Planet Green and Aurelia Marketing & Research	Boekos, probably customers Boekos, TNO, Philips DAP Avebe (Dutch starch producing cooperative firm) Campina (major Dutch dairy firm) Both companies involved the same entrepreneur, Planet Green used various specialised suppliers	At least partly internal investments Proposal submitted to EET programme, but not approved Internal funding and probably other sources Internal funding, € 3 million alone for the marketing campaign Payments by customers
Government domain		
Activities	Actors	Resources
Various activities at the Ministry of the Environment stimulating vegetarian foods on the short term Funding Profetas (1999) Transition monitoring research using NPF as case study (2002)	Ministry of the Environment, environmental organisations, research contractors Ministry of Agriculture MNP, Ministry of the Environment,	Internal capacity, existing policy programmes, allocation of budgets at the ministry Internal budgets at the ministry Regular and project based governmental funding
Pubic domain		
Activities	Actors	Resources
V-day & other public oriented activities, symposiums	NVB, Aurelia, producers, environmental organisations, animal welfare organisations	Partly funded by the Ministry of the Environment
Dialogue on CSR in supermarket using meat alternatives as a vehicle Incorporating meat alternatives in public environmental campaigns Monitoring meat and fish alternatives in supermarkets	NM, supermarkets, other NGOs Milieu Centraal NVB, Aurelia, animal welfare groups	Internal / external sponsoring Internal budget, provided mainly by government Unknown

The most extensive activities in terms of resources were found in the research and business domains. They include R&D at or commissioned by companies, as well as public research. A landmark was the Profetas programme (www.profetas.nl, Aiking *et al.* 2006), which involved more than 50 people, including fifteen fulltime researchers. The financial resources of the research activities were provided mainly by ministries, by government innovation programmes like BTS (Company-oriented Technology Stimulation) and AKK (Agro Chain Knowledge), or by various Dutch research councils such as NWO, MaG and STW, whose budgets are also provided by the government. There was also substantial co-funding by companies involved.

Table 2 also shows that only a limited number of the activities in the business domain were fully financed by companies themselves. These include 'regular' product development and product introductions by the producer of meat products and meat alternatives Boekos (until it was taken over by a competitor), regular production and product development activities by the SME trade firm Planet Green and dairy firm Campina's investments in product development and marketing of Vales, which is a superior dairy protein based meat alternative. Other activities like the product development trajectory of the mould protein ingredient by DSM food specialties and an unknown partner downstream (that replaced Boekos after it was taken over) and product development and product testing activities in catering chains by an alliance led the catering company Sodexo were partly financed by government agencies, such as Senter-Novem and AKK and partly paid for by the companies themselves. However, next steps and activities are likely to be fully covered by their own investments and will grow as. When companies decide about production and market introduction, large budgets are needed like in the case of Campina's Vales.

A major contribution of the government thus consists of funding research through, for instance, innovation programmes, 'special' funding like the contribution of the Ministry of Agriculture to the Profetas programme, or academic research councils. Further activities in the government and public domains, with the aim of stimulating present meat alternatives were considerably more modest in terms of resources. However, the Ministry of the Environment organised quite a number of activities and financed NPF-related activities by public interest groups, such as the Dutch Vegetarian Society, animal welfare groups and environmental organisations, which led to public-oriented events, such as V-day (Vegetarian Day) and counting of vegetarian products in supermarkets. Although more modest budgets the latter activities may have (had) a considerable direct and indirect impact among public interest groups and the public and might become crucially important. For instance, they may have contributed to supplying adequate information to public interest groups, tackling the concerns regarding GMO at these organisations, raising awareness among the general public, or stimulating the demand side. Meat alternatives have also become more important at organisations providing environmental information to consumers, like Milieu Centraal.

Each activity comprises a temporary or more structural set of actors who are involved in the activity, constitute that activity and in many cases have been able to mobilise the resources for the activity. When there are successful joint applications for (external) funding, then actors also have contracts that tie them to the activity and each other. The temporary network of the NPF backcasting experiment has thus evolved into several networks surrounding particular activities for which resources have been mobilised successfully. It has clearly not evolved into a single large NPF network in the Netherlands, but into a number of decentralised networks that are sometimes connected, and sometimes not, or just a little. Most activities started as alliances preparing proposals and mobilising actors and funds. In several cases this did not succeed and the attempted activities were abandoned. In other cases activities were abandoned by stakeholders because expectations were not met, or due to strategy changes.

It is possible to identify network clusters that consist of several activities that overlap in actors or show similarity in type and scope of activities, although not all activities can easily be positioned in such clusters. The clusters that have been identified to a large extent adhere to the four domains, albeit not completely. A first cluster is the research network around

Profetas, which also involves a number of public and private financing parties. Although this activity was also supported (and co-funded) by companies, the Profetas programme was essentially an academic research endeavour. Nevertheless, the companies involved considered the Profetas programme a serious endeavour that directly and indirectly supported and legitimised their activities in the field of NPFs and meat alternatives.

Secondly, there is a business cluster involving R&D in large food companies in the Netherlands. Although this cluster includes R&D activities at Avebe, Boekos, Campina and DSM Food Specialties, their activities are not closely related, but have similar scopes. This cluster also includes testing NPFs and meat alternatives in the catering and related product development in which the catering company Sodexo had the lead. A third cluster consists of SMEs involved in the production of meat alternatives, which includes the activities of Planet Green. This cluster does not seem very much influenced by the NPF backcasting experiment, but they did 'their own regular thing' in a gradually growing market. A fourth cluster concerns the activities by the Ministry of the Environment, which consists of various policy-making activities, stimulating dialogue on the topic of meat alternatives and related funding of activities by public interest groups. This cluster is strongly related to various activities by public interest groups and their networks, although the latter can also be seen as a fifth cluster.

4.2 Vision: guidance, orientation and competition

Guidance has been analysed in terms of (1) collective projection, (2) synchronisation and alignment among stakeholders from different backgrounds and, (3) alternative rules.

The core of the future vision on Novel Protein Foods comprises the **collective projection** and could be found among many of those involved in identified follow-up and spin-off activities. The core included the business opportunities of NPFs and meeting consumer demands regarding taste, texture and other characteristics using new technology, as well as that NPFs and improved meat alternatives will play a significant role in future diets and will lead to considerable environmental improvement at the same time. By contrast, in most follow-up and spin-off activities the collective projection has also evolved, resulting in adjustments, due to ongoing insights, inputs by new actors, or by adding domain or organisation specific elements. For instance, the ambition of 40% replacement of meat in the Netherlands was abandoned in the Profetas programme, whereas it was also reframed into a global issue instead of a national issue. Adjustments of the future vision on NPF also took place in other activities and their constituting networks. For instance, at the Ministry of the Environment, the long-term and abstract future vision on NPFs was considered not to be adequate for short-term policy-making that should target current consumption, products and production and its existing stakeholder target group meetings on food. As a result, the vision was reformulated into facilitating vegetarian foods and new vegetarian food products on the short term, raising consumer awareness, stimulating the demand side and dealing with potential barriers, such as the GMO concerns among environmentalists. Vegetarian organisations and animal welfare organisations were attracted to the vision of NPFs, because it could be connected to their future visions of a meat-free, animal friendly society.

The vision also led to **synchronisation** and alignment among the actors from the various domains and disciplines involved in the various networks, which can, for instance, be illustrated by the multi- and inter-disciplinarity of the Profetas programme, as well as the involvement of actors and stakeholders from different societal domains. In addition, the identified clusters (above) coincide more or less with adjustments in the vision. It can thus be argued that particular cluster of networks constitute particular varieties of the NPF vision that share a joint core and that this stimulates synchronisation in particular cases and domains, sometimes by adjusting (slightly) its focus and scope.

Changes in the future vision also affected the **alternative rules** (system) embodied in the future vision. For instance, narrowing the range of sources to green peas has huge

consequences for the supply system and the players in such a system. When moving the issue to a global level to include oil-containing crops, many new actors get involved and other existing rules, like WTO trade agreements, are challenged and may need to be altered. Another example concerns the meat alternative chains that were tested in the catering company Sodexo, as this required new agreements, contracts, etc.

Orientation of the future vision can be defined in terms of (1) cognitive activation, (2) mobilisation of actors and resources, and (3) presence of daily decentralised coordination.

The future vision including its varieties evolving in different activities and supporting networks provided cognitive challenges and facilitated **cognitive activation** towards the vision in research, policy-making, business and the public domain. This is not only about generating new knowledge through research as took place in the Profetas programme and in other R&D projects. It is also about realising opportunities and developing them cognitively in such a way that they can support further action by actors in all domains

Both the generic future vision and its network-specific varieties were used successfully to **mobilise** actors and resources, as is shown Table 2. For instance, the number of companies participating in the Profetas programme had initially increased to five (while there were three in the NPF project). The number of research groups increased as well, while there was also a broadening in disciplines. Furthermore, the Profetas research alliance successfully mobilised resources from various research councils and other sources, though it took considerable efforts and time.

Did the future vision also provide daily **decentralised coordination** in the different networks? At least, it provided sufficient stability to establish the activities summarised in Table 2 and to mobilise sufficient resources and actors to realise them. However, there was also a dynamic at work in the content and framing of the future vision resulting in several adjusted visions that had the same core but were also a bit different, while there were exits and entries of actors in the various networks. It may be that the precise content of the future vision mirrors in a way also the constellation of the network. In that case the future vision must have enough flexibility to survive these adjustments and to enable entries, which must be followed to provide sufficient stability for the ongoing activity.

The dominant vision of regular meat production and consumption remained strongly present, although the environmental burden and animal welfare issues are ongoing concerns. With regard to other **competing visions**, it can be mentioned that several alternative and possibly competing visions could be traced. Firstly, there is the competing vision of organic meat and eating less meat that is supported by a large part of the environmental movement. Furthermore, a vision of a meat-free society was supported among vegetarian and animal welfare organisations. As the vision on NPFs can be seen as a step towards this further-reaching vision, it was judged positively by the vegetarian NVB.

4.3 Institutionalisation and institutional resistance

A clear instance of **institutionalisation** is the fact that the Profetas programme had a broader effect on the food industry and food knowledge infrastructure in the Netherlands, while generating such a knowledge base is accompanied by processes of institutionalisation among the actors involved as well in the acting networks. At Wageningen University and Research (WUR), NPF-related topics have become part of various other research programmes, which points to further institutionalisation. As a result of this, companies became interested in the scientific results and the potential business opportunities. This probably supported that Campina wanted to become a player in the field of meat alternatives.

Institutionalisation also refers to research practices; within WUR the Profetas programme was regarded as an interesting and positive multidisciplinary research effort involving technical, social, economic and environmental sciences within a single programme. A related instance of institutionalisation is the fact that the food industry considered Profetas a positive example of the emerging approach of consumer-oriented food product development. Another

instance is that the research and product development activities at DSM Food Specialties and an unknown customer goes along with institutionalisation among the actors involved, which is also the case in the activity led by Sodexo and the producer Schouten Europe.

Meat alternatives in the sense of food products have become more important at various public interest groups, such as Milieu Centraal, the vegetarian NVB and animal welfare groups. This can also be seen as a form of institutionalisation, as well as the gradual growth in the consumption of meat alternatives. Another example is that meat alternatives are increasingly seen as protein foods by the Product Boards for Livestock, Meat and Eggs (PVE), and included in their consumer surveys on meat and meat products.

Examples of **institutional resistance** include that the Ministry of Agriculture has shifted its position with regard to NPFs. It wants to leave the topic to market parties, arguing that there has developed a niche market and that sufficient fundamental knowledge is available for product development trajectories fully funded by companies. But this changed view also seems fuelled by a wider concern at the ministry that meat and meat products are economically important and that competing meat alternatives should not be nurtured too much. Another instance is the uneasiness of Unilever about focusing on the pea in the Profetas programme, which may partly be explained by institutional resistance at Unilever against sources other than soy, because the company has such a large knowledge base about and experience with processing soy, whereas a critical attitude towards multitude is widely present in Unilever due to a failed market introduction in the late 1960s.

5. Conclusions

The NPF backcasting experiment has resulted in a normative future vision and in involvement and commitment among a wide range of relevant stakeholders, which also led to mobilising sufficient resources from different sources. In addition, it has led to higher order learning among participating stakeholders with regard to the problem definitions, alternative solutions, shifting principal approaches and priorities, and the backcasting approach.

The future vision has gradually developed during the course of the backcasting experiment. It also had different functions at the same time, such as a tool for integration and analysis, or as a shared vision providing guidance and orientation to the backcasting experiment and its activities. The vision offered guidance in the sense that it served as a collective normative projection to the future, allowed for synchronisation and alignment among researchers from different disciplines and among participating stakeholders from different domains. Alternative rules were also derived from the future vision and guided activities and discussions. The future vision also provided orientation that facilitated and stimulated cognitive activities in research and non-research topics. The vision was also used to mobilise (financial) resources and to attract stakeholders that could enter the backcasting experiment at several moments, while others changed their type or degree of involvement. The vision in combination with the project structure and the available resources also provided daily coordination among the temporary network.

Significant follow-up and spin-off associated with the topic of NPFs could be identified in all four domains: the research, business, government and public domains. Follow-up and spin-off include activities involved both stakeholders who had been actively involved in the backcasting experiment and new stakeholders. The identified activities can be framed as networks, consisting of activities, constituted by actors and enabled by mobilised resources. Several separate and decentralised networks have been found around the identified activities, while several clusters of networks could be determined as well. The volume of mobilised resources has also increased since the backcasting experiment. The numbers of actors involved and the degree of their involvement in the activities have increased too, although several stakeholders left or decreased NPF-related activities.

The vision was widely around in the activities, but has been adjusted and to some extent redefined during most activities. This was partly because of the entrance of new actors,

resulting in that the adjusted vision was widely supported by major stakeholders. However, a stable core of the future vision has remained that assumes that sustainable non-meat protein foods will become important in people's future diets.

The follow-up and spin-off have also come along with wider effects and instances of institutionalisation, while also examples of institutional resistance could be found.

A key mechanism in establishing follow-up activities starts when participating stakeholders see opportunities in the future vision enabling behavioural alternatives. These stakeholders are represented by individuals who either need support from higher levels in their organisation or personally have the capabilities to initiate activities in their own organisation. In many cases cooperation evolved around specific activities or proposals for activities (and raising funds for these through other external channels). This happened, for instance, in case of the Profetas programme, the policy-related activities at the Ministry of the Environment and the public interest groups. Interestingly, not all these people were strongly involved in the NPF backcasting experiment. Sometimes, stakeholders got acquainted with the backcasting experiment and its outcomes by 'regular' dissemination activities or through persons who had been involved in the backcasting experiment.

6 Wider effects, system innovation and governance

Are the follow-up and other effects the signs of an emerging system innovation? The present activities are still at a niche level, although networks, activities and alliances are growing. The various clusters of activities can be both seen as one large niche and as a set of related niches. Also, a knowledge base has been established in the innovation system that may eventually result help turn the generated knowledge into products. The consumption of meat alternatives is slowly, but steadily growing in the Netherlands. One signal is the recently launched meat alternative by Campina that is based on dairy proteins. This points to both a growing awareness of the opportunities of NPFs and changes in the rules of the existing socio-technical system. All these signals can be seen as seeds for a system innovation. They relate to the initial phases of the conceptual perspectives proposed by Rotmans *et al.* (2001) and Geels (2005).

Thus, despite significant follow-up and spin-off of the NPF backcasting experiment in different domains and involving various actors from those domains, there are no signs of an imminent system innovation towards sustainability yet. There are potential future drivers, like the dynamics among food multinationals, a possible trend of increasing meat prices over 10 to 15 years and an increasing protein deficiency in other parts of the world. Although these factors may become decisive, they have not become so yet, while the vested interests of the meat sector still play an important role as well. A possible threat can emerge too when government-funded activities are completed and business actors are not yet ready to do larger investments. It can therefore not be determined if established activities and their networks, for instance around the Profetas programme, will continue or will disappear.

Therefore, more time is needed before it can be evaluated if the participatory backcasting experiment on NPFs in the Netherlands will have contributed to a system innovation towards sustainability in which meat alternatives and NPFs have substituted a considerable share of the consumption and production of meat and meat products. Finally, it may also be necessary to initiate additional facilitation in order to make a next step. But if and when that will happen, who will have to take the lead?

This raises the issue of governance for system innovations towards sustainability. Voß *et al.* (2006) have plead for reflexive governance that include both that includes reconsidering and adapting actors' and individuals' own actions and behaviour, as well as reconsidering and adjusting structures and institutions, which relates in a way to the ambitions of Beck's reflexive modernisation. Next to these fundamental aspects, there are also the issues of coordination or even control and what government should and can do. Focussing on the

results presented and discussed in this paper, three implications for governance can be mentioned.

Firstly, the case study results indicate that backcasting stimulates higher order learning with regard to complex sustainability problems and radically different sustainable solutions as well as with regard to shifting approaches and priorities. This suggests that governments should facilitate, support and commission or even organise backcasting experiments.

Secondly, this case shows that the Dutch government was crucially important in funding follow-up and spin-off activities in different ways, but tends to stimulate especially knowledge development and research. The first implication is that with regard to desired system innovations more is needed than funding knowledge development and research. However, it does not mean that budgets should be automatically reserved for follow-up and spin-off of favoured or selected backcasting experiments. It might be important that visions attract leading individuals and actors that together are capable of mobilising resources in competition with other visions and alliances in order to assure that only the strongest visions and networks go on, instead of nurturing weaker visions and networks too long.

Thirdly, the activities identified in this case each had their own supporting network, while various clusters of activities could be identified that related to various adjusted varieties of the future vision that were at play in these different clusters of activities. This points to decentralised (daily) coordination across clusters of activities and across domains by the vision in its various adjusted varieties having a shared core. It is also likely that the adjustments result in a better fit with the belief systems of the stakeholders involved and thus can provide guidance and orientation in a better way to the identified clusters. As a consequence, adjustment may be a condition for further diffusion of the vision into series of new activities in line with the vision. In other words, new entrants learn from and are influenced by the vision, but may also add their interpretations, perceptions and priorities and influence the vision. The relevance is that coordination should not be too strong. By contrast, it seems to work better that different networks and clusters set their own adjustments and initiate their own activities. It might be that the loosely coupled and related clusters make up a strong niche together being rather independent from one another and each having their own strongholds and leading actors within their own domain, instead of having a governmental agency that tries to control and coordinate a blueprint-like trajectory.

Finally, conclusions, wider effects and implications for governance are based on a single case study. Further research into the impact of other backcasting experiments may substantiate these conclusions and shed a better light on governance implications and recommendations on how to organise backcasting experiments as well as how to facilitate follow-up and spin-off including their governance. First results have been reported recently (Quist 2007).

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