

Chapter 12

The climate-neutral society: opportunities for change

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Introduction

If there is one thing that has become clear from the contents of this book, it is the complexity of the transition processes that are inevitably linked to realizing a society that is (almost) climate-neutral. Whatever the strategy to reach the substantial reduction of greenhouse gas emissions by 80 per cent in 2050 compared to 1990 levels, the implications are imposing. The overall objective of this book is to explore the changes in social trends needed for long-term substantive reductions in greenhouse gas emissions and to assess the prospects for realizing such trend breaks in society.

Numerous technological or macro-economic studies have been performed, identifying both options and strategies that contribute to a climate-neutral society. In its role of conducting research for policy, the Dutch National Research Programme on Global Air Pollution and Climate Change (NRP) has supported a number of projects examining the elements of a 'climate-neutral society', thus exploring routes of greening society. The focus in these projects is often on analysing new technologies capable of enabling a drastic reduction in greenhouse gas emissions. In essence, these future studies consist of expert opinions about new technologies (the tempo of innovation and diffusion and the feasibility of their application). As such, these research activities combine technological, environmental and (in many cases) economic knowledge in forecasting models. Economics comes into the picture if learning curves, describing the reductions in costs of innovations over time, are included in the models. The effects of policy mixes are also assessed in some of these studies. They tend to present our salvation through technology, with a touch of economic instruments or regulations added, depending on the scientific discipline of the authors.

Within the NRP, a range of social scientists have also been working on social causes, responses and possible solutions. This has provided an opportunity to comment on these techno-economic images of the future from the perspective of required social change. We invited these researchers to join us in a '*back to the present*' exercise: commenting on what would need to change in order to arrive at these alternative futures. Reasoning backwards (or 'back-casting') in this way is relatively easy, enabling one to identify institutional and cultural barriers and the like. Of course, in doing so, we had to look into an uncertain future – into an ever-dynamic and changing social, political, international, economic and technological environment. Recognizing and accepting this societal complexity may very well be the

first crucial step towards managing the major changes required if the objective of protecting the climate over the long term is to be realized. This book shows that, in terms of technological options and further development and implementation of policies that can contribute to the key objective, there are countless possibilities, opportunities and starting points throughout society. We have learned much about existing barriers in the domains that have been discussed and analysed, which in turn provides some insight into how to overcome them. We have also seen promising developments in changing practices. In this final chapter, we will be looking forward again, discussing the findings of these confrontations and trend breaks and evaluating the most important dilemmas. We focus on some critical issues and opportunities for change, being aware that our final remarks may offer more food for thought and further research than providing answers to questions.

Social trend breaks: opportunities

Looking back at the analysis in the previous chapters, we can see that required changes in social trends have been identified, as well as opportunities and instruments for effecting these changes. The *'back to the present'* exercise highlights the contrasts between the social implications of the future visions and the situations that exist today. In this chapter, we will look at some of the main conclusions that affect the spheres of consumption, production and, consequently, governance. We will discuss just a few of the issues covered in the book – the subjects chosen here serving merely to illustrate the line of reasoning that arose from the *'back to the present'* exercise.

Consumption

Looking at the sphere of consumption, visions A and B in Chapter 2 are constructed on the basis of their performance in delivering sufficient reductions in greenhouse gas emissions. It is expected that there will be changes in *household consumption* in reaction to transitions in the areas of product development, food production, housing and transportation. In the future scenarios, such changes are simply presupposed, not analysed. Recent environmental policy has addressed citizens as consumers, but with only marginal results. Chapter 5 showed that in practice, the variation in the total environmental impact of the consumption packages of individual consumers can be quite strong, even within income categories. Moll

Box 12.1

Required trend breaks, opportunities and instruments in the area of consumption

Required social trend breaks	Addressing various segments differently (Ch. 3, 5)
Opportunities	Willingness to act for part of population (Ch. 5)
Instruments	Direct routes: information, pricing, standards but: diversification of approaches (Ch. 5) Indirect routes: producers, physical infrastructure (Ch. 5)

and Groot-Marcus in Chapter 5 discussed some experiences with the perspective project and ecoteams that could help consumers to assess the environmental impact of their consumption and redirect their routines. This can be effective in the short term, but research shows that consumer appreciation of consumption alternatives does not correspond with their environmental impact. As discussed by Moll and Groot-Marcus in Chapter 5, some of the behavioural alternatives with the greatest impact are perceived by the public as indispensable, whereas some with small impact are perceived as easily replaceable (as shown in the study of Uitdenbogerd et al.).

Providing consumers with information to allow them to assess environmental impact themselves has a limited effect. The public response to such information is interpreted by consumers within the context of their own value system and worldview, which are, by nature, very diverse. The argument here is that using strategies based on awareness and rational decision making is only effective for some of these cultural-normative groups.

What does this teach us about the way to achieve a climate-neutral society? It opens two routes for reducing the ecological impact of consumer behaviour. The first avoids dependency on consumer (and voter) behaviour. Instead, it depends completely on producers improving their products, reducing their environmental performance and ensuring full market breakthroughs by means of financial instruments. In this case, policies for climate change will have hardly any effect on the everyday life of citizens. The second route depends on the social responsibility and moderation of informed consumers. In this approach, the government addresses consumers, either directly or indirectly, by means of information about the necessity of changing consumption patterns and with product-related information (such as ecolabels, information services, stimulation supply, etc.). The risk of the first route is that it can result in reduced public commitment, market pressure and political attention to issues on climate change. The second route is risky because it does not consider the variety of consumer attitudes, behaviour and values.

In regard to consumer commitment, an interesting development occurred during the writing of this book. The introduction of a green electricity scheme in a liberalized energy market in The Netherlands in the summer of 2001 resulted in a growth of the market share of green electricity from 4 per cent to 12 per cent of all Dutch households in only five months! This development can be examined from various perspectives (see Box 12.2), but it shows one thing very clearly: intentionally changing institutions and the roles of social actors can create change, even in consumer behaviour.

Yet, we have to keep in mind the importance of existing values and worldviews, which act as a substrate on which perceptions of environmental issues, attitudes and factual behaviour flourish. In many cases, these values and worldviews may explain why issues on climate change are disregarded or rejected. If these different values and worldviews are not taken into account, the result can be only marginally effective policies. But we must also note that in the long run, values and worldviews can be challenged. They do, in fact, evolve along with new technological systems and their accompanying institutions. Knowing this opens the way for the deliberate design of new technologies and products along with efforts to act upon their social interpretation and appreciation. And more: the variety of values

*Box 12.2***Going Dutch for green electricity**

'Green energy' is a general term for renewable energy that private persons and companies buy from their energy supplier. At the moment, green energy refers to electricity from renewable energy sources. However, in the future it may be possible to buy 'green gas' or 'green heat'. Those who want to use renewable energy could decide to place a wind turbine or solar system on their roof. However, not everybody has the time, knowledge, skills or space required. And it is often more advantageous to produce renewable energy on a large scale or at more optimal places. Therefore, some years ago, energy companies, encouraged by environmental NGOs, started offering renewable electricity to their customers, as an alternative to electricity generated with coal, gas or oil.

The market for green energy is growing rapidly. In The Netherlands, households and companies bought 350 million kWh of green electricity in 1999. In October 2001 this figure had grown to 2.4 billion kWh (still only about 2 per cent of total electricity consumption), with companies purchasing over 200 million kWh and about 700,000 households (about 10 per cent of Dutch households) participating. In May 2001 the number of households was only 250,000, less than 4 per cent. So, in five months, the number of participating households almost tripled. In two years, the green energy market increased by almost a factor of seven!

This enormous increase is a consequence of the tax benefits that are given to both producers and (notably small) consumers of green energy and the fact that this 'green' part of the energy market was being liberalized as of July 2001. Because of this, some retailers offer green energy at the same price or even below the price of 'grey' electricity. Combined with support from environmental organizations (e.g., the World Wide

Fund for Nature and Greenpeace) and increased marketing efforts by energy distribution companies to assure market shares in the liberalized market, the number of green clients has boomed.

The green energy market is facilitated by a system of green certificates, which enables the separate trade of electricity and certifies the 'greenness' of this electricity. It also ensures that each certificate that is being sold to final consumers was actually generated by a renewable energy source. Since the Dutch scheme allows for import of certificates (under certain conditions), it, in combination with the renewable energy certificate system (RECS) at the European level, is in fact an international certificate trading system that could be transformed into an emission (permit) trading system.

The opening of the market for green energy to small consumers (resulting in competition between retailers), the financial support on the demand side (resulting in interesting margins for the retailers), and the creation of a level playing field for energy retailers by the introduction of a certificate system, were the main drivers of this rapid trend break in the green energy market.

However, one can still criticize elements of the system: the effectiveness of the system is impressive, but it is to a large extent the effect of the tax benefits (notably at the demand side), equivalent to more than € 150 per ton of CO₂. This is relatively expensive and inefficient compared to other instruments supporting greenhouse gas or energy saving options, and it is questionable whether the problems on the supply side will be solved in the politically desired timeframe (because of problems related to NIMBY, licences, etc.). Furthermore, the system is not designed to support innovation as such (only if the market asks for it, e.g., solar photo-

Box 12.2 continued

voltics is sometimes included in the green energy portfolio), which could result in a technological lock-in.

On the other hand, the tax benefits are financed with revenues from the Dutch regulating energy tax on non-renewable energy.

Such combined taxation and tax exemption schemes have proven to be effective in other fields of environmental policy as well (e.g., introduction of lead-free gasoline and catalyst cars).

Source: from www.greenprices.com (November 2001).

and world views within segments of society can and should be used as the starting point for designing a variety of strategies.

Such an approach does not allow us to amend the mixture of technologies in both visions of the future directly, but it does involve a trend break in the routine sequence of designing policies: starting from a techno-physical and economic approach and resulting in a policy mix of technical measures, subsequently provided with instruments for implementation. Following this argument, social, cultural and institutional criteria should be included in the assessment of mixtures of technical measures.

Production

Visions A and B in Chapter 2 depend largely on technological transitions within the sphere of production, including energy production and distribution. Looking at industry today, changes such as clean process technologies, clean fossil fuels (in combination with CO₂ storage), improving energy efficiency, ecodesign and improving material efficiency and organizing take-back schemes are required. This type of change is not entirely new. As a matter of fact, the 1990s showed a trend towards the greening of production pursued as a co-responsibility of market and state. In this development, both the modes of governance and the perception and methodology of improvement of environmental performance have changed drastically. In the mode of governance, traditional central governance by means of coercion and incentives has been modernized and extended with two complementary strategies: the first being a strategy of interactive management and internalization and the second being a strategy of enabling self-management (Vermeulen, 2002).

However, in order to reach the overall level of an 80 per cent reduction in emissions, there needs to be an enormous increase in effort. Industries going in this direction will have to deal with major challenges: it will require increased collaboration among producers along the entire production cycle, going back all the way to raw material extraction abroad. This implies co-operation among mining firms, firms supplying semi-finished products, final producers, traders and recycling firms. A second indispensable step will be the promotion of system innovations (see Chapters 4 and 7). Experience in these fields is growing but tends to be restricted to either one step back in the production cycle (working together in product partnerships) or one step ahead (i.e., organizing the collection and recycling of products).

*Box 12.3***Required trend breaks, opportunities and instruments in the area of production**

Required social trend breaks	<p>Increased attention for dematerialization through life-cycle management (Ch. 7)</p> <p>Dissemination of climate-oriented designs for environment (DfE) and system innovation (Ch. 7)</p> <p>Increased market demand as stimulus (Ch. 7)</p> <p>Increased attention to threats of ICT energy savings (Ch. 8):</p> <ul style="list-style-type: none"> ▪ rebound ▪ suboptimal organization and infrastructure ▪ insufficient information to user ▪ lack of co-operation
Opportunities	<p>Positive effects sufficiently demonstrated (Ch. 7)</p> <p>Eco-efficiency of system innovations (Ch. 7)</p> <p>Easy integration in existing policies (Ch. 7)</p> <p>ICT can make minor contribution to preventing climate change, but can facilitate other processes (Ch. 8)</p>
Instruments	<p>Standards for recycled material (Ch. 7)</p> <p>Take-back systems (Ch. 7)</p> <p>Sustainable consumption policies can create market demand (Ch. 5, 7, 11)</p> <p>DfE practices in ICT innovation practices (Ch. 8)</p>

Such forms of co-operation are perceived by innovative firms as opportunities, but they are far beyond the (perceived) span of control of the majority of firms that are using defensive innovation strategies.

For these firms, activities aimed at co-operation over a product's life cycle and product stewardship bring along new uncertainties with unclear commercial benefits. Discourses on the political level and public debate on policies aimed at climate change do not create an incentive for these groups of firms to get involved in such activities. For them, getting on the road to the greening of production is clearly a social dilemma. With enough reasons not to start (such as unclear economic gains, lack of experience and uncertain market demand), why be the first to do so?

From their perspective, there is no clear, collectively supported, long-term target in the field of climate policy, which strengthens this attitude among the majority of firms to wait. But this inertia can be broken down. Experience with the interactive management policy strategy in The Netherlands in the 1990s shows that breaking down such inertia in the absence of long-term perspectives is possible and may offer a way out of the social dilemma (Vermeulen and Weterings, 1997; Glasbergen, 1998; Driessen and Glasbergen, 2002). In The Netherlands experience in the 1990s, in order to establish a consensus on long-term environmental targets for specific industrial sectors and ways to achieve them, the initial step towards industry was essential. This included organizing mechanisms of institutional learning, reporting and monitoring to ensure feedback on the course of the

process. The experience with the COOL dialogue (Chapter 11) shows that for certain sectors, discussing long-term climate targets and their implications can be a fruitful part of a long-term strategy.

Co-operatively defining long-term targets and ways to achieve them may be the essential first step to bring the majority of manufacturers in the production sector together to collaborate over the product life cycle, ecodesign, system innovations, material efficiency, etc. Some research on 'chains of producers, sellers and users' of consumption goods is currently underway (Ministerie van VROM, 2000, p19). Systematically addressing all relevant groups of products by collaboratively defining sustainable production for each 'sector' would be trend breaking.

Looking for the outcomes of the future visions for the agenda of social environmental science emphasizes the need for research in understanding, explaining, designing and managing processes of long-term innovation (focusing on its social and institutional context). This has recently been addressed as 'transition management', which, as a form of facilitating governance, is discussed in Chapter 4.

Looking back at the future visions in Chapter 2, transition management calls for abstaining from using future scenarios to identify allegedly 'optimal mixes' of technical measures on the basis of techno-physical and economic assessments. Transition processes will benefit from pluriformity in learning and competition between various trajectories.

Governance

The discussion above brings forward the question of the implications for governance. The visions themselves do not contain governance strategies, the relation between state and market or the role of civil society. In the context of the *'back to the present'* exercise, various authors reflected upon the role of general economic instruments, the implications of the legal system and the role of local government. The reflections on developments in the field of producers and consumers, given above, also have implications for governance.

As a general line arising from these reflections, we can say that changing towards a climate-neutral society requires the organization of institutional learning processes, offering guidance and creating a common ground by means of long-term targets. This is in contrast to advocating forms of central management on the basis of coercion and economic incentives. On the other hand, the aforementioned plea for consensual governance might be unbalanced if it implies abandoning all forms of general regulative and financial instruments.

One of the discussions in this area is the role of pricing greenhouse gas emissions (see Chapters 5, 7 and 11), particularly in regard to permit trading in realizing a climate-neutral society. Energy pricing is an important condition for successful climate-change policy, but low prices make it an uphill battle. Some scholars in the field tend to be very optimistic about the ability of permit-trading schemes to ensure the reduction of greenhouse gas emissions. This is based on the inclusion of a cap (an absolute maximum) on allowed annual emissions, decreased yearly. In Chapter 9, Woerdman et al. have designed a feasible permit-trading scheme. They argue that the market will ensure that emissions are reduced in the most cost-effective way. Their argument goes beyond that, claiming that the

*Box 12.4***Required trend breaks, opportunities and instruments in the area of governance**

Required social trend breaks	<p>Technology policies address system innovations (Ch. 7)</p> <p>Linking short-term policies with long-term policies (Ch. 7)</p> <p>Introducing new policy paradigms, based on ET (Ch. 9)</p> <p>Changing towards a legal system based on the social legal system approach (Ch. 10):</p> <ul style="list-style-type: none"> ▪ performing 'legal consequences analysis' in climate policy studies (Ch. 10) ▪ giving a prominent role to local authorities (Ch. 6) ▪ ensuring local political attention (Ch. 6) ▪ improving local external integration (Ch. 6)
Opportunities	<p>Eco-innovators as drivers of industrial transformation processes (Ch. 7, 11)</p> <p>Administratively efficient ET scheme (Ch. 9)</p> <p>Policy attention in 40 per cent of municipalities (Ch. 6)</p> <p>Potential effectiveness of local policies (Ch. 6)</p>
Instruments	<p>Instruments aiming at (Ch. 4):</p> <ul style="list-style-type: none"> ▪ technology variation ▪ actor interaction and learning ▪ market selection ▪ strategic niche management <p>Emission trading for companies, households and transport (Ch. 9)</p> <p>More government responsibility (Ch. 10):</p> <ul style="list-style-type: none"> ▪ norms and instruments of public law ▪ strong enforcement ▪ strong public participation ▪ broad legal protection <p>Organizational and process improvements (Ch. 6)</p> <p>Climate policy management systems (Ch. 6)</p> <p>Participatory policy-making tools available (Ch. 6, 11)</p> <p>Pricing (Ch. 5, 7, 11)</p>

complex policy mix of central management, interactive management and stimulation of self-management should be abandoned – thus pleading for a major administrative trend break.

Such debates challenge the emphasis on consensual governance. Can a sweeping statement like the one made above be substantiated? Can a central management strategy be promoted solely by incentives, relying on the invisible hand of the permit-trading market? This idea has found its way into the implementation of the Kyoto agreement, where emission-trading markets are being organized.

One major obstacle to permit trading, in the stubborn practice of political decision making, would be the essential feature of annual decreases in the absolute maximum of allowed emissions. But even supposing that this can be done, it

remains to be seen whether price incentives alone will be enough to speed up the dissemination of climate-neutral appliances and renewable energy in industries and households. Looking at research on the diffusion of energy and environmental innovations, economic evaluation (prices) is only one of the variables explaining the pace of diffusion. Placing these issues on the business agenda, differences in business innovation strategies and innovation capacities, along with features of the adopter's socio-institutional environment, are as relevant to the rate of diffusion as pricing is. One example is that the legal system of environmental legislation is mainly based on stationary norms and protects the rights of industry once regulations and permits are issued. This hampers the opportunities for governments to impose more stringent rules on a regular basis. The discussion about the difficulties of making the step from incremental innovations to system-wide innovations should also be kept in mind here. Although they can provide a strong incentive, price incentives alone are not enough to elicit such changes in everyday routines.

Criticizing an exaggerated belief in economic instruments should, however, not distract our attention from another important issue: what would be a proper balance between central steering (including pricing of CO₂ emissions) and collaborative strategies for steering? Social, policy and economic scientists often tend to take a position at one side of the dichotomy or the other, stressing the imperfections of the opposite side. We should recognize that in practice both strategies are applied, affecting the individual behaviour of organizations and individuals either directly or indirectly. Research on assessing these effects comprehensively, focusing on the mutual effects of both strategies, deserves more attention (the importance of existing rules and incentives as a substrate for consensual strategies and vice versa: the importance of consensual strategies as a substrate for greater acceptance of, and compliance with, rules and the recognition of financial incentives).

Future scenarios, as discussed in Chapter 2, do not include discussions about the effects of the strategies covered in this section. But by their very nature, they elicit reflections of the kind shown in this book. Thus, such a '*back to the present*' exercise forms an invitation to develop this kind of social science reflection in a more systemic way.

Dealing with social dilemmas

The discussions above show us that technological answers, as suggested in the future visions, are a first step in exploring strategies for a climate-neutral society. They serve to inspire imaginable futures. Often the step after analysing various alternative futures is to select the most optimal mix. In this book, the opposite is done: on the basis of environmental social science reflections on the future visions, arguments to develop as much variety in technological options as possible and to create pluriformity are made. It is clear that an analysis of the social consequences of technological visions of a climate-neutral future leads to a response that is different from the seven dilemmas put forward in Chapter 3, and different from responses that might arise from a techno-economic evaluation of such scenarios.

Maybe this is most evident for dilemma 1: a '*small number of decision makers' versus 'decentralized, multiple and diffuse decisions'*. It might seem to be attractive to follow a line of reasoning oriented towards technological feasibility, environmental effectiveness and cost-effectiveness focusing on large-scale solutions within the control of national governments. However, the visions presented in Chapter 2 suggest, in themselves, that we will need a large variety of options. Focusing on a small number of large-scale technologies may be attractive in the short run, but in the long run, an 80 per cent reduction in emissions will have to come from a wide array of options. Moreover, it is unlikely that other actors in society will not be needed to make their contribution in their roles as producers, consumers, investors, decision makers, motorists, voters, etc. For example, in the COOL project, it was concluded that the role of consumers in climate policies should be strengthened. Consumer demand may be able to accelerate technological change and to change supply. Moll and Groot-Marcus (in Chapter 5, on households) tend to be somewhat pessimistic about the willingness of consumers to take on this role, but at the same time, they also see various opportunities for (indirect) policies to realise climate-neutral consumption patterns in households. Consumers, in their role as citizens, are also crucial to sustaining a political willingness to deal with the climate problem, even if social costs for (at least) some actors will increase.

Stressing multiple trajectories brings us to the question of governance addressed in dilemma 5 as the *contrast between central steering and co-production*. In our view, the issue is to find a proper balance. Arentsen et al. (Chapter 4) ask whether a generic approach on its own can promote the development of radical solutions. Many of the authors advocate an approach that combines co-production and co-evolution to get beyond incremental improvements and to achieve system innovations to deal with the climate problem. Another reason for tailor-made approaches is the need to address rebound effects and the effects of growing wealth. As pointed out in the chapters by Moll and Groot-Marcus (Chapter 5), Hekkert et al. (Chapter 6) and Slob and van Lieshout (Chapter 7), economic growth often counteracts the environmental effects of options and policies, resulting in an absolute increase of emissions. Long-term policies may also need long-term standards and proper monitoring systems to deal with this problem (as suggested in the COOL dialogue to introduce a long-term standard for CO₂-neutral transport fuels, for instance).

In contrast to the plea for co-production and co-evolution is the idea, proposed by Woerdman et al. (Chapter 9), that emission-permit trading will be the only policy instrument necessary to bring about an 80 per cent reduction in emissions. As argued in the previous section, putting our trust solely in central steering and market incentives will not be effective. This debate also came up in the COOL dialogue (Chapter 11), where a tailor-made approach, matching the stages of technology development, was suggested.

With respect to a differentiated, tailor-made approach aimed at co-operation, the 'persistence' of a differentiated approach over a long period of time (demanding sustained political and societal willingness to deal with the problem) and the effectiveness of such policy strategies to deal with a large number of small actors can be questioned. However, this argument is also relevant for emission-trading schemes, relying on a sustained political and societal willingness to maintain peri-

odic reductions in the national emission cap. Here, a proper balance of strategies may bring mutual advantages: co-production enabling learning in specific social sectors, thus contributing to a higher level of commitment, and central strategies with market incentives providing economic motives and a mechanism for achieving eco-efficiency.

This notion of balancing central steering and co-production may also offer guidance with respect to dilemma 3: *'focusing on climate change' versus 'pursuing sustainability'*. It may be necessary to focus on climate change to ensure the attention and commitment of the various implementing actors in society. On the other hand, from the perspective of businesses, consumers, local authorities, etc., this does not seem wise. Consumers do not perceive climate as a separate issue (Chapter 5). Businesses work with integrated assessment methods and management systems (Chapter 7). Local authorities apply, or should apply, integrated environmental policies when *'enhancing external integration'*. These tendencies require policies aimed at sustainability in the broad sense instead of focusing on climate change as a separate issue. But this refers mainly to such things as operational policy instruments and assessment methods. Here again, we suggest a proper balance. Where we advocate tailor-made approaches and dialogues on climate policies with specific sectors, co-operation can very well focus on climate change, relevant options for reducing greenhouse gas emissions and their implementation strategies. When such dialogues have led to shared visions on the application of options, instruments for implementation will be required. These would then best be linked to existing integrated policy instruments, assessment methods and management systems aimed at sustainable development.

The fourth dilemma of *'demystification' versus 'need for increased awareness of change impact'* has not been dealt with explicitly in this book. One disadvantage of generic, mostly *'invisible'* solutions and instruments, with a focus on large-scale technological trajectories, may be that climate change will not get the level of political and public attention required for sufficient diffusion of other necessary technologies. Chapters 5 and 6 both show acceptance of and motivation for change within groups of consumers and municipalities. But the other side of this coin is that far larger proportions of these consumers, of local politicians, etc., are not very interested. This calls for increased awareness, but not in the form of apocalyptic messages that will not fit their frames of reference.

A solution here may be contained in dilemma 6: *'transition through co-benefits' versus 'inevitability of a special approach to climate change'*. Many of the chapters have touched on this issue. It always seems wise to start promoting options that generate co-benefits. Stressing co-benefits and giving priority to options with clear co-benefits may be helpful in persuading groups that would otherwise not be successfully approached into adopting these innovations. Yet, the discussions in this book do not provide any clues to whether options with clear co-benefits together have sufficient reduction potential. In the literature, estimates of the magnitude of the net ancillary benefits and costs of greenhouse gas emission reductions in industrialised countries vary widely. But according to the Organisation for Economic Co-operation and Development, even the most conservative estimates suggest that they are significant and may offset as much as one-third of the abatement costs for modest mitigation efforts (OECD, 2001).

No direct reference has been made to dilemma 2: *'acting now' versus 'delayed response'*. Arguments for delayed response mainly rest on technological calculations and expectations about the speed of diffusion. If one thing has become clear in this book, it is that there are many socio-cultural obstacles to the dissemination of technologies. This calls for maximum variation and competition between technological trajectories, instead of relying on an optimistic belief in technological progress alone.

The final dilemma, number 7 *'decentralization and Europeanization' versus 'the need for national direction of the transition'*, raises the question to what extent national governments in Europe (especially of small and medium-sized countries) will have enough independence for decisive national policy making. As discussed in Chapters 4 and 6, governments at the national and European level are supposed to play a leading role in stimulating innovation and facilitating social transitions. On the other hand, some of the proposed generic instruments, such as permit trading, require implementation at only the European level. It doesn't make much sense to set a Dutch national standard for CO₂-neutral fuels when it is clear that on this level, a European approach is needed. System-wide changes would seem to require even more international co-operation than an incremental approach. Relatively small countries, but front-runners like The Netherlands and the Scandinavian countries, may take a leading role here by showing success from innovative approaches.

These examples illustrate the importance of finding the right level of action. But as the chapters on households (Chapter 5) and local authorities (Chapter 6) show, there is also a great deal of room for policies at the local level, as well as the national (the chain-management approach, advocated by Hekkert et al. (Chapter 7) and technology policy strategy advocated by Arentsen et al. (Chapter 4)). The COOL approach, as discussed in Chapter 11, in which a combined local and national approach is advocated by some sectors, could provide long-term direction for local authorities.

It is clear that with these general approaches to climate change, the *'back to the present'* exercise results not in new future visions, but rather, in amended visions made up of mixes of technological infrastructures. The virtue of the exercise is in exploring social constraints and thus setting new agendas for environmental social science and for policy-making.

Key issues in the transition towards a climate-neutral society

At this stage, finalizing our *'back to the future'* exercise by looking forward again, we want to discuss three issues that, in our view, are the main issues coming out of our reflections and discussions during the process of writing and editing this book:

- organizing the transition towards climate-neutrality as long-term learning and feedback
- balancing generic central steering and specific co-production
- handling conflict and equity.

Long-term learning and feedback

In our efforts to move in the direction of a climate-neutral society, it is essential to adopt a long-term perspective and to enable a collective learning process in society. The visions that were presented in Chapter 2 of this book are a minor example of such long-term perspectives. Starting from clear, long-term targets for reduction at the sectoral level and translating them into development trajectories over time (e.g., by applying back-casting techniques), the consequences of short-term actions over the long term become very apparent. The debate should focus not on choosing selective packages of technologies, but on enabling pluriformity and competition.

In an environment that constantly changes over time, while long-term goals remain fixed, it is necessary to regularly update and check the level of success of short-term policies. When seen in this way, it is not a matter of fixing a strategy for the coming half century, but rather a matter of agreeing on procedures to keep track of long-term objectives over time, in the face of the inevitable unexpected developments.

The dynamics of managing long-term transition and, at the same time, maintaining long-term goals, requires intensive and almost continuous dialogue with relevant and diverse groups of stakeholders. Many chapters in this book and, in particular, the experience gained in the COOL dialogue described in Chapter 11, indicate the need for continuous communication about interests, perspectives, possibilities and responsibilities among a multitude of actors. An ongoing dialogue (as a learning process) among the actors involved may help:

- further develop a long-term vision and social strategy for achieving a climate-neutral society
- enable stricter targets over a long period of time
- enable governments to develop consistent policies and learn which options should be favoured for the long term in order to realize institutional change and to anchor new ideas.

Balancing central steering and tailor-made co-production

With all its diverse topics and domains, this book has also shown that depending on the actor, the option or technology and the context, there is a strong need for 'tailor-made' policies to support efforts required in a specific area or domain. Households and the urban environment have specific, local interests, and applying new technologies or modifying consumption patterns have specific, local requirements. In contrast, the petrochemical industry operates in a global market with fierce competition; it may be served far better by agreements across the sector, worldwide, with allowances for emission trading. In one area, the development of new technologies is a main issue; in another, it is just a matter of implementing schemes and making minor changes in the market place. The key issue here is that specific conditions require specific management and policies in order to be successful. Success also requires a decisive government that is capable of developing, implementing and maintaining such sector-specific policies in close co-operation with relevant actors in the market and civil spheres. 'Decisive government' here is not meant as 'strong' government fiercely applying top-down command-and-control mechanisms, but as a forward-looking government, as stable as the North Star, that persistently shows the direction for development.

Such a general requirement contrasts strongly with some current trends where national governments and industrialists rely more and more on market mechanisms and put more and more trust in generic policy instruments (such as tax measures and emission trading). Related to this point, we have concluded that emission trading will certainly play an important role in the (inter)national arena (as is also argued by Woerdman et al. in Chapter 9) but it might be insufficient in itself to ensure that the major transitions required to meet long-term objectives take place. Emission trading (or 'flexmechs') should therefore be part of a balanced mix of policy instruments and strategies, on both the international and the national level.

Handling conflict and equity

The COOL dialogue discussed in Chapter 11 showed that, in the future, controversies may arise around some major technologies necessary for the transition to a climate-neutral society, such as the application of CO₂ storage, biomass and wind, since there will be some groups of actors who oppose them. Controversy and conflict can also grow – or may already exist – between different technological approaches. The visions in Chapter 2 have shown that it is possible to have competing technological routes for reaching the same objective. Here, we have stressed the virtues of diversity and competition, but one should also be aware of the drawbacks arising from controversy and conflict between the visions and among the various actors and sectors.

Chapter 4 by Arentsen et al. illustrated the difficulties of managing technology development and technological change. It is tempting to think that the climate problem can easily be solved by technological means, but the requirements for actually having the essential technologies available at the right time are complex. Arentsen et al. have highlighted the possibility of more coherent technology management over a prolonged period of time. Conflicts will arise between different technologies and approaches, but these frictions may also serve as a motivation for change. In policy and technology management, explicit attention should be paid to this. Risks are involved in developing alternatives, and a long-term perspective and stable long-term policies are essential. It is unlikely that market parties will accept all the risks in developing options, infrastructure and the like. Therefore, a key role is identified for (supra-)national governments in creating the right conditions for technological change and development. Inevitably this will involve high costs in the early years. On the other hand, improved international collaboration and stable long-term policies may yield considerable efficiency benefits in the long term.

Another source of conflict lies in equity. The burdens (or benefits!) of transitions will not be distributed evenly throughout society; neither will the efforts essential to obtaining change and activity be equally distributed throughout sectors and domains. Many actors depend on each other for success, and in order to keep their efforts focused on long-term goals, dialogue and debate are essential on many levels: sometimes local, sometimes national, and often international. There are very positive examples of such dialogues – which can serve as models or starting points for dialogues about long-term climate objectives – such as the COOL dialogue discussed above, the protocol of Montreal on reducing the emissions of CFCs to protect the ozone layer (a so far successful example of an international

agreement on a global environmental problem!) and the agreement in the world's adipic acid industry to join efforts to develop and implement new technologies that phase out the significant N₂O emissions in this sector (Reimer et al., 2000). In fact, the global climate conferences (Conferences of Parties) are a spectacular result of international dialogue on a global issue in their own right, uniquely resulting in agreements among a large number of countries. Much is to be improved in this type of process, but dialogue has already led to consensus and an understanding of the problems and the need to deal with them. Such examples show that dialogue about complex problems and long-term objectives is possible and can yield good results.

The authors of this book were asked to go beyond the borders of their scientific expertise in a challenging exercise aimed at shedding light on issues related to 'trend breaking' from a scientific perspective. An understanding of the science and practice of trend breaking or transition management will be essential if substantial reductions in greenhouse gas emissions are to be realized in the long term. Yet, there is little experience in this field and clear itineraries are not yet available. We hope that this book will inspire you to make your own contribution to the art of trend breaking.

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