The Feasibility of Systems Thinking in Sustainable Consumption and Production Policy

A research report completed for the Department for Environment, Food and Rural Affairs by BRESE, Brunel Business School, Brunel University.

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Glossary

Backcasting	The process of predicting the future based on the examination of several alternative scenarios -- usually representing different desirable states. The question then asked is, '*if we want to arrive at Scenario A, what trends would we need to change to get us there?*'
BRESE	Brunel Research in Enterprise, Innovation, Sustainability and Ethics (Brunel Business School, Brunel University).
Defra	Department for Environment, Food and Rural Affairs.
Multi-level Perspective	Developed to provide insight into the transition process. This perspective distinguishes three levels:
* *Landscape*	The environment within which the transition (i.e. system change) takes place.
* *Regime*	The system that ensures that a basic societal function can be adequately fulfilled e.g. the production and consumption of goods and services.
* *Niche*	Where radical innovations can emerge and new concepts can be tested in a protected environment.
SCP	Sustainable Consumption and Production.
Systems thinking	An approach for environmental and innovation policies that emphasises the need for radically and more (eco-) efficient changes in systems of consumption *and* production (as opposed, for example, to a focus on end-of-pipe technologies or individual products).
Transition	A *process* of change in a system which happens over a long period of time and is characterized by complexity and uncertainty. * *Complexity* is caused by the large number and diversity of the stakeholders and sectors involved in the process of change. * *Uncertainty* is due to the unpredictability of the course the transition will take and the influence of exogenous factors
Transition dynamics	The replacement of a dominant regime by a new regime comes about because the processes on all three levels of the multi-level perspective are interlinked and mutually reinforcing: * *Landscape* - Changes at this level (e.g. concern about climate change) can exert pressure on the existing regime and lead to changes in how procedures are implemented or specific systems modernized. * *Niche* - The regime can also come under pressure if innovations developed and tested at niche level become so attractive that they make a breakthrough at regime level and conquer markets. * In order to achieve a desired transition, each level must be subject to a policy that takes the other levels into consideration. * Transition policy must ultimately take effect at regime level but

	must simultaneously cover the landscape and niche levels so that change can come about at all at regime level.
Transition management	Aims to initiate transitions by means of a participatory and gradual method of management and steering - characterized by adjusting, influencing and adapting.
Transitions policy	The policy developed for transition management.
Valley of death	Refers to the difficulty that R&D projects face in moving from research to the market.

Executive Summary

1. The overall **aim** of this research project has been to gather evidence on the feasibility of systems thinking for sustainable consumption and production (SCP) policy in the UK.

2. The project is set in the **context** of a raft of new pervasive problems - such as climate change, biodiversity and resource depletion - that have come to dominate the environmental agenda. These problems differ in scale and complexity from earlier environmental issues such as water pollution, acid rain, local air pollution and waste problems. Moreover, these new environmental problems often come *on top* of the older problems, although some of the latter have been substantially reduced in developed economies at least. Arguably, these new pervasive environmental problems require new kinds of solutions and policy approaches, which do not *replace* but *complement* existing approaches.

3. Representing a new phase in the evolution of environmental policy, **systems thinking** calls for a much greater and more explicit integration of environment and innovation policies in order to address new pervasive environmental problems. This approach recognises that the environmental impact of a single product, process or practice can only be understood through an appreciation of the wider system of which it is part. The very large improvements in environmental efficiency (possibly by a 'Factor 10' or more) required to address new environmental challenges may only be possible through system innovations, i.e. shifts to new systems or substantial reconfigurations of existing systems. Such systemic changes (more commonly referred to as 'transitions') thus seek to find new, radically more (eco-) efficient ways to fulfil societal functions and human needs (e.g. mobility, food, housing, heating, lighting, etc).

   A number of European countries are beginning to incorporate a systems thinking approach into their SCP policies and strategies. However, it is still too early to assess the impact of such approaches on the effectiveness of emerging national SCP policies.

4. In light of the project's aim and context, the specific **objectives** of the project have been:
   1. To identify and explain key 'systems thinking' concepts and approaches of relevance to SCP policy.
   2. To prepare three short case studies of international examples of new systems thinking in environmental policy.
   3. To explore and review the relevance and applicability of 'systems thinking' concepts and approaches (tools), together with insights from the project's case studies, for UK SCP policy.

5. The **methodological approach** adopted for the project was primarily a desk-based review of academic literature and policy documents, supplemented by a small number of telephone interviews and e-mail exchanges with relevant case-study contacts Three cases were identified that illustrate varying degrees of systems thinking and its implementation in environmental, innovation and energy policy: i) the **Dutch Energy Transition Programme**; ii) the **Austrian Technologies for Sustainable Development Programme**; and, iii) the **Energy2000/SwissEnergy Programme**. The most advanced of these, in terms of explicit systems thinking, is the Dutch Transition Programme.

6. Systems changes are complex. By this we do not simply mean that they are complicated or difficult, but rather that such changes can best be understood by drawing upon concepts and ideas from evolutionary, systems and complexity theory. Hence we characterise systems changes or '**transitions**' as co-evolutionary, multi-dimensional, multi-actor, multi-level; radical; long-term; non-linear process

7. **Transitions policy concepts and approaches.**
The literature and case studies suggest that policies seeking to purposefully encourage transitions towards sustainability have more chance of success if they follow a two-pronged strategy:
   - Increasing pressure on the existing system e.g. with financial and regulatory instruments (such as carbon tax, emissions trading, emission norms, performance standards),
   - Stimulating the emergence and development of radical innovations in niches (protected environments where radical innovations can emerge and new concepts can be tested).

   With regard to the second part of this strategy, several instruments can (and should) be used to influence niche-oriented innovation processes:
   - **Learning processes**: R&D subsidies, subsidies for programmes of experimentation and pilot projects, codification and exchange of experiences, training and competence building, procurement (which should then be oriented not only towards cost/efficiency, but also towards innovative potential).
   - **Networks**: network management methods, participatory methods to facilitate multi-stakeholder interactions (which include tensions and power struggles), creation of new platforms or meeting places, debates and negotiations, include outsiders or frontrunners, not only established system actors.
   - **Visions**: foresight exercises, scenario workshops, ways of translating long-term visions to short-term actions, methods for opening up (out of the box thinking) and closing down (reaching temporary closure).

   Furthermore, the effectiveness of such policy approaches will also depend upon:
   - **Vertical support**: Political and policy support from ministers and senior officials in departments enhances the legitimacy and visibility of transition initiatives (e.g. embedding within and reinforcement by broader national environmental policy strategies).

- **Horizontal coordination**: Environmental (transition) policies are more effective if they are aligned with sector-specific policies (in transport, energy, housing, economy, spatial planning, etc).
- **Policy cultures and capabilities**: Different countries have different policy styles, which may hinder the transfer of 'best practices'. Such transfer also depends on the 'absorptive capacity' of intended users, i.e. the accumulated capabilities. It takes time to learn and build up new policy capabilities.

In addition, comparison of the three cases studies revealed the following:

- They had **different starting points for policy reform**, not necessarily from within the sustainable production and consumption policy sphere (e.g. environmental policy with broad systems ambitions; innovation policy with the addition of systemic elements; national energy policy reform).
- They show a similar **tendency to result in rather technology-oriented innovation programmes** despite the original intentions to be more holistic. This suggests that some degree of institutional innovation may therefore be required to overcome such inertia.
- The **policy blend** between fostering new niches and pressuring existing regimes varies between cases.
- An important approach to expectations is to **frame the problem in a consumption-oriented fashion** around the fulfilment of a societal need without any preconditions about technology or business sector.
- **Participative foresight methods** seem more helpful than reliance on expert forecasting or predictive approaches.

8. **Going forward.**

The growing recognition of the importance of systems thinking, and the experience gained so far in the cases analysed suggest that it would be useful if the UK contributed to the exploration of this approach. An initial way forward could involve the following:

- Convening an international workshop on systems innovation and SCP policy to share emerging thinking, review national experiences and identify opportunities for future collaboration and joint initiatives.
- The establishment of a systems innovation capability building network comprising UK policy makers, academics and entrepreneurs involving a learning partnership with the Netherlands Transition Competence Centre.
- Identifying priority areas within the SCP Programme's policy domain where experimentation with systems-oriented initiatives might add value. For example, exploring options for: i) radically reducing resource use and waste; or ii) consumer behaviour and sustainable food systems.

In addition:

- The SCP Programme should take a lead in promoting dialogue on systems thinking and transitions-oriented policy approaches with key stakeholders across government, such as the Sustainable Development Commission, BERR and the Technology Strategy Board. This could be done with a view to creating an interdepartmental systems thinking 'think-tank' made up of relevant representatives and spearheaded by Defra. The

think-tank would serve as a means to promote horizontal collaboration across a range of policy areas with an interest in or responsibility for SCP.

- Longer term, Defra, CLG, the new Department for Energy and Climate Change and others should consider the creation of a system-oriented 'platform' or 'arena' in collaboration with an agency concerned with innovation policy such as the Technology Strategy Board.
- The theme for such a 'platform' or 'arena' should avoid a specific technological area. Rather, it should focus on a topic such as the low carbon 'household', 'neighbourhood' or 'community'. This would take advantage of the development of UK policies such as the Climate Change Bill which are exerting pressure on the carbon-based regime by supplementing it with a new niche-oriented systemic policy initiative.

1 Introduction

Project aims and objectives

The aim of this report is threefold:

1) To identify and explain key 'systems thinking' concepts and approaches of relevance to SCP policy.

2) To prepare three short case studies of international examples of new systems thinking in environmental policy.

3) To explore and review the relevance and applicability of 'systems thinking' concepts and approaches (tools), together with insights from the project's case studies, for UK SCP policy.

Systems innovation and the need for new environmental policy approaches

During the 1990s and early 2000s, a raft of pervasive new problems such as climate change, biodiversity and resource depletion, have come to dominate the environmental agenda. These pervasive problems differ in both scale and complexity from the environmental issues of the 1970s and 1980s, such as water pollution, acid rain, local air pollution and waste problems. Moreover, these new environmental problems often come *on top* of these older problems, although some of the latter have been substantially reduced in developed economies at least (e.g. in Europe and North America the problem of acid rain has largely been addressed through end-of-pipe measures such as flue gas desulphurization).

Arguably these new pervasive environmental problems require new kinds of solutions and new policy approaches, which do not *replace* existing approaches (e.g. based on life cycle analysis or chain approaches), but *complement* them. With regard to climate change, for instance, the Stern Review (Stern, 2006, i) argued that we need:

> *transitions to a low-carbon economy. (…) The economic analysis must therefore be global, deal with* long time horizons, *have the economics of* risk and uncertainty *at centre stage, and examine the possibility of* major, non-marginal change (our emphasis added).

Likewise, to address global warming, Tony Blair called for:

> *a green technological revolution comparable to the Internet (March 29, 2006)*

These calls for transitions or revolutions imply the need for changes in systems (such as transport, energy, agricultural and waste handling systems). This is because the very large improvements in environmental efficiency (possibly by a 'Factor 10' or more) required to address these challenges may only be possible through system innovations, i.e. shifts to new systems or substantial reconfigurations of existing systems (Figure 1).

Figure 1 suggests that whilst substantial environmental improvements (of a 'Factor 2') can be achieved through system improvement and more incremental innovations,

to deal with longer-term challenges (e.g. climate change, one planet living, etc.), policy will need to stimulate the emergence and shift to new systems.

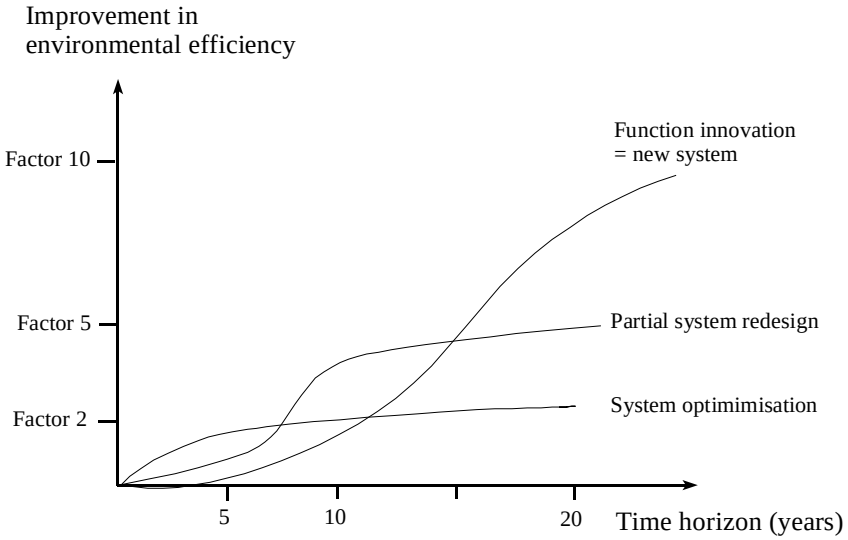

Figure 1. System optimisation versus system innovation (Weterings et al, 1997)

Indeed, interest in systemic approaches to sustainability arises from the recognition that the environmental impact of a single product, process or practice can only be understood through an appreciation of the wider system of which it is a part. This has been prompted both by increasing awareness that environmental impacts may be hidden and indirect and also that rebound effects may offset narrowly defined eco-efficiency gains. One of the key observations in recent years is that the lower environmental impact of a single product may actually be accompanied by higher environmental impact at a more systemic level due to increases in consumption.

Systems change thus represents a new phase in the evolution of environmental policy approaches since the 1960s: 1) end-of-pipe solutions, 2) process efficiency measures and industrial ecology (closing of material loops), 3) product life cycle approaches (supply chains, product road mapping), 4) system changes (Figure 2). These policy approaches become increasingly systemic. While the second and third phase also have systemic elements which aim to *improve* existing systems (closing loops and improving chains), the fourth phase aims to *change* systems. That is, systems change seeks to find new radically more (eco-) efficient ways to fulfil societal functions and human needs (e.g. mobility, food, housing, heating, lighting, etc). The phases are not sequential, but cumulative, implying that old and new policy approaches co-exist and complement each other.

This fourth phase of systems change is very much still ‘in the making’. As with any policy innovation, there is uncertainty about ‘best practice’ and a need for ongoing experimentation and learning. Critically, however, it requires much greater and more explicit integration of environment and innovation policy. Different countries can be seen to be, more or less explicitly, pursuing somewhat different approaches towards systems change within their environmental and SCP policies (although some elements appear common to a number of countries).

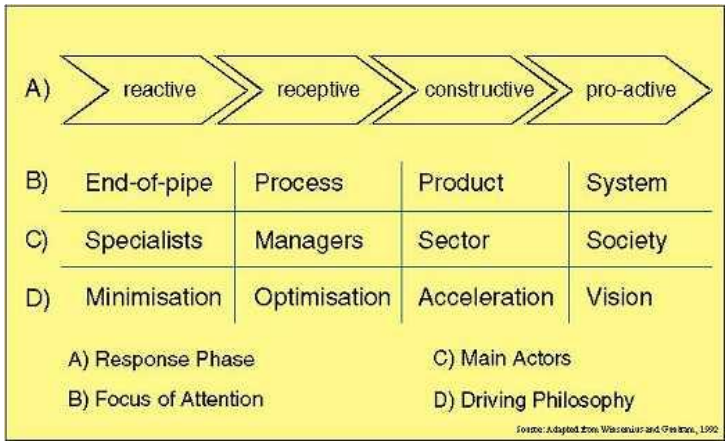

Figure 2. Phases in environmental policy approaches (United Nations, 1999)

What we mean by systems change

Systems changes are complex. By this we do not simply mean that they are complicated or difficult, but rather that such changes can best be understood by drawing upon concepts and ideas from evolutionary, systems and complexity theory. Hence we characterise systems changes as co-evolutionary, multi-dimensional, multi-actor, multi-level; radical; long-term; non-linear process (Elzen *et al*., 2004: Kemp, Loorbach & Rotmans, 2006; Geels, 2005a; 2005b):

- **Co-evolutionary and multi-dimensional**: system changes not only involve new technologies but also accompanying social changes (new markets, regulations, consumer norms and behaviours, industry structures, business models, infrastructures, etc). This means that system changes do not have a single cause or come about as a result of a single intervention, rather they are the result of co-evolutionary developments across multiple domains (technology, economy, politics, culture, ecology, etc).
- **Multi-actor**: system changes involve interactions between a broad range of social groups and stakeholders, e.g. firms, policy makers, consumers, suppliers, distribution and retail chains, civil society and NGO's, etc: often 'outsiders', who are not involved in or who are only marginal to the existing system, play a critical role.
- **Multi-level:** system changes typically involve interactions between processes at different scales. These are often described in terms of niche, regime and landscape developments (See Box 1 below).
- **Radical:** systems changes are radical in that they result in a shift from one system to another. Such processes tend to be gradual rather than revolutionary, with smaller and larger steps accumulating over time.
- **Long-term:** typically a transition - a change between one system and another - will take several decades.
- **Non-linear:** the rate of change during a transition is not constant, but varies over time. Typically four distinct transition stages are apparent (see Figure 5 below).

Box 1. The multiple levels of systems change

Niche - where radical innovations can emerge and new concepts can be tested in a protected environment.
Regime - ensures that basic social functions can be adequately fulfilled, i.e. people are housed, have leisure time and produce goods and services. In terms of energy supply, the regime consists of such elements as technical installations and systems, energy infrastructure, energy markets, preferences, modes of use, policy measures and policy instruments.
Landscape - determines the environment within which the transition (system change) takes place. This involve issues such as: the type, volume and distribution of energy resources, how the climate change issue is perceived, international agreements, political cultures, outlooks on the world, values and principles (VROM-RAAD & ALGEMENE ENERGIERAAD, 2004, 10).

Some of these systems concepts and ideas have already entered into the mainstream environmental policy arena. Indeed, the emergence of Sustainable Consumption and Production (SCP) as a distinct policy domain implicitly incorporates some of these notions, especially the idea that sustainable solutions require technological and social change. For example, the UK Sustainable Development Strategy states that meeting the challenge of living within the environmental limits of a '*one planet economy'* will '*require innovation in both technologies and behaviours'* (HM Government, 2005, 44).

Box 2. Functional product service systems

The 'functional product service systems' approach also recognizes the systemic and multi-dimensional character of systems change. This approach conceptualises the provision of functionality at the broadest system level possible (Maxwell et al. 2006). It starts with the functionality or basic human, and then investigates with which system (material mode) this can best be fulfilled, meeting the triple bottom line of sustainability and other requirements such as cost, quality and technical feasibility. The co-evolutionary aspect is explicitly recognized:

> "In terms of the big picture, wider SCP solutions encompass varied aspects, e.g. physical infrastructure, technology innovations, diverse policy, legal and market instruments, new business and consumer models (…) and involving wide system level stakeholder engagement, have been identified as necessary (Maxwell et al., 2006, p. 1477).

How do systems changes come about?

Because system changes are complex (multiple dimensions and stakeholders), large-scale and long-term processes, directing or steering them is a daunting challenge. Moreover, we know that existing systems tend to resist radical change.

This is because incumbent actors tend to favour incremental innovation and systems *improvement.* Such 'lock in' is the result of a host of mechanisms which promote stability and resistance to change, e.g. sunk investments (in skills, capital equipment and infrastructures), vested interests, organizational capital, shared belief systems, legal frameworks that create uneven playing fields, consumer norms and lifestyles).

At the same time many radical (R&D) innovations, which could ultimately replace or help reconfigure systems, face a so-called 'valley of death'[1] on their journey to commercialisation (Auerswald & Branscomb, 2003; see Figure 3). It is hard for radical innovations to get a foothold in mainstream markets as they initially tend to be characterised by relatively low performance and high price. They may also face a mismatch with aspects of the existing system (e.g. lack of infrastructure, consumer demand, regulatory problems, etc).

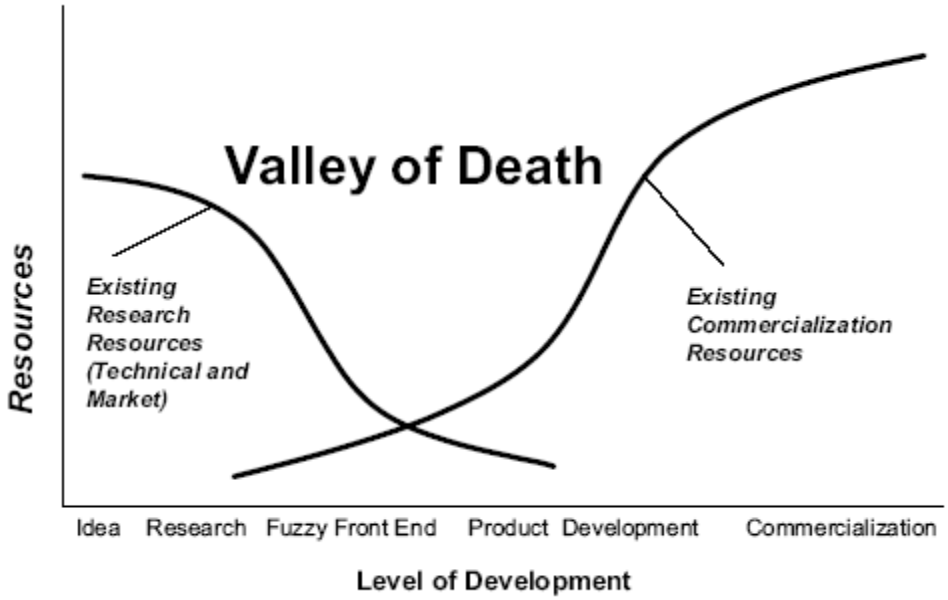

Figure 3. Innovation and the 'Valley of Death' (Daily & Sumpter, 2005, 78).

However, from historical studies of technology and society we know that system changes, or transitions, have frequently occurred in the past (Tarr, 1981; Correljé and Verbong, 2004; Belz, 2004; Geels, 2005b, 2005c, 2006). These studies highlight the importance of a number of innovation processes, particularly in the early stages of a transition.

Niches

Niches play a crucial role in seeding systems changes by facilitating learning and providing bridges across the valley of death. These can be 'market niches' where particular consumers/users accept teething problems because the innovation offers certain advantages for their user requirements. Or they can be 'technological niches', which are societal experiments with new innovations, often supported with public subsidies, regulatory exemptions, temporary infrastructure provisions, innovation oriented procurement policies, etc.

Wider systems changes (resulting from the breakthrough of niche-innovations) usually depend on the confluence of processes at three levels (Figure 4):

- Internal momentum of niche-innovations (e.g. price/performance improvements, support from powerful groups, bandwagon effects)

[1] Refers to the difficulty that R&D projects face in moving from research to the market.

- External pressure as a result of changes in the external environment or broader societal landscape
- Weakening of the existing system (regime) (e.g. increasing problems, tougher regulations, changes in market conditions, higher prices, etc), which create windows of opportunity. However, niche-innovations can only take advantage of these windows if they have sufficiently stabilized and gained some momentum.

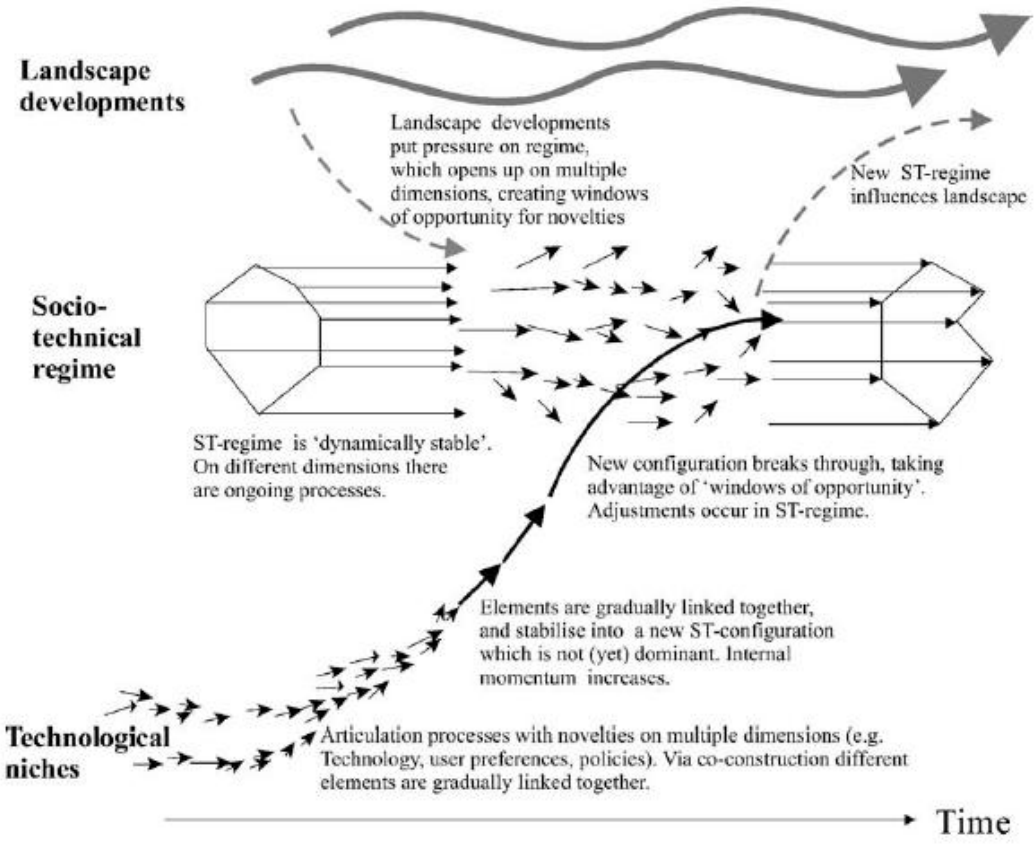

Figure 4. A Dynamic Multi-Level Perspective on System Change (Geels, 2004, 915).

From the perspective of niche-innovations, a systems change, or transition, can then be viewed as having an S-shaped form (known from diffusion theory) with a prolonged period of pre-development (experimentation, learning, network building, guiding visions and expectations), followed by take-off (accumulating momentum), breakthrough (and fight with existing system), and stabilization of a new system (Figure 5).

Transitions towards sustainability are inevitably more complicated than Figure 5 suggests.

- Firstly, there will usually be not one but multiple niche-innovations competing with each other to replace the existing system. It is impossible to know in advance which one, if any will be successful (no 'picking the winners').
- Second, niche-innovations may have (unexpected) side effects or unanticipated consequences, which change perceptions of their sustainability (see for instance the current debate on biofuels).

- Third, diffusion does not necessarily follow a smooth S-curve. Niche-innovations may gain a foothold in some market niches, but fail to get wider consumer acceptance or be delayed by a lack of required infrastructural provisions.
- Fourth, breakthrough and diffusion may depend on alignments with complementary technologies or niche-innovations (for example the uptake of fuel cell vehicles would require the development and deployment of hydrogen storage and refuelling technologies and infrastructures). It is often difficult to predict in advance which innovations will in the future lead to interesting 'new combinations'.

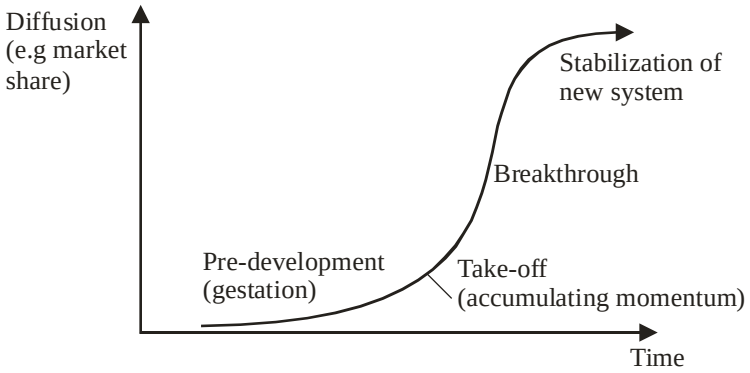

Figure 5. Stylized shape of transitions (based on Rotmans et al 2001)

Learning

System innovation is fundamentally about learning. Niches provide protected spaces for learning about newly emerging systems. Learning processes in technological niches are *not just* about technology, but also about social and behavioural change (user preferences and social acceptance, supply chains, business models, institutional and regulatory adjustments, etc). The accumulation of learning through niches can promote the development of new markets and seed wider systems changes.

Networks

Radical niche-innovations are often developed and nurtured by outsiders and fringe actors, although sometimes the established firms may also promote radical innovation in order to diversify. To introduce their innovations into the wider world, innovators need to engage with other actors and stakeholders (e.g. lead users, policy makers, capital providers, supply and distribution chains, etc.). Also real-life experiments and pilot projects involve the creation of social networks.

There is a tendency in innovation policy to involve only supply side actors (firms, universities, etc.). For system innovation, however, broader networks are required to facilitate multi-dimensional learning. Broad stakeholder networks, including outsiders, may also enhance the innovativeness of projects by bringing in new perspectives and experiences. These network processes are not necessarily harmonious, and usually also involve tensions, disagreements, power struggles, etc.

Expectations

Individual innovators are always guided and motivated by personal visions. But also emerging communities (e.g. the solar cell or wind turbine community) share particular expectations about future chances and opportunities. On the one hand, such long-term expectations guide their activities (e.g. R&D investments, decisions for project design) and provide some directionality to short-term learning processes. On the other hand, such communities articulate inspiring and promising visions to attract attention from funders (such as policy makers) and enrol other actors into their social networks (Brown and Michael, 2003; Eames *et al*., 2006; Geels and Raven, 2006).

Transitions Policy

In recent years a growing number of European researchers and policymakers have begun to explore the extent to which it is possible for policy to purposefully encourage transitions toward sustainability (Rotmans *et al*., 2001; Kemp *et al*., 2001; 2007; Loorbach, 2007). Below we summarise some the main findings and ideas, from the literature on systems change and transitions policy.

A broad range of policy instruments can (and should) be used to influence transitions. The literature suggests that such policies have more chance of success if they follow a two-pronged approach:

2. Increasing pressure on the existing system e.g. with financial and regulatory instruments (e.g. carbon tax, emissions trading, emission norms, performance standards),
3. Stimulating the emergence and development of radical innovations in niches[2].

With regard to the second part of strategy, several niche-oriented innovation instruments can be used to influence the processes discussed above:

- Learning processes: R&D subsidies, subsidies for programmes of experimentation and pilot projects, codification and exchange of experiences, training and competence building, procurement (which should then be oriented not only towards cost/efficiency, but also towards innovative potential).
- Networks: network management methods, participatory methods to facilitate multi-stakeholder interactions (which include tensions and power struggles), creation of new platforms or meeting places, debates and negotiations, include outsiders or frontrunners, not only established regime actors.
- Visions: foresight exercises, scenario workshops, ways of translating long-term visions to short-term actions, methods for opening up (out of the box thinking) and closing down (reaching temporary closure).

Furthermore, the effectiveness of such policy approaches will also depend upon:

- Vertical support: Political and policy support from Ministers and senior officials in departments enhances the legitimacy and visibility of transition initiatives

[2] Application of only niche-oriented policies (as happened in the Dutch case) may lead to many new initiatives, but these will subsequently face difficulties in wider diffusion as they are blocked by stable regimes. Application of only regime-pressure policies (taxes, regulations) tends to lead to *improvement* of existing regimes, not to the development of radical alternatives (Kemp, 1997).

(e.g. embedding within and reinforcement by broader national environmental policy strategies).

- Horizontal coordination: Environmental (transition) policies are more effective if they are aligned with sector-specific policies (in transport, energy, housing, economy, spatial planning, etc).
- Policy cultures and capabilities: Different countries have different policy styles, which may hinder the transfer of 'best practices'. Such transfer also depends on the 'absorptive capacity' of intended users, i.e. the accumulated capabilities (Cohen and Levinthal, 1990). It takes time to learn and build up new policy capabilities.

This general strategy does *not* suggest that transitions can be managed by one actor (e.g. the government) or steered in particular directions. Instead, the policy strategy is best characterized as 'goal oriented modulation' (Kemp et al 2007), proceeding in small steps in a particular general direction; ideas about this direction may change as actors gain experience while making the steps. This strategy thus aims to connect long-term thinking with short-term action without relying on planning. The creation of niches and the use of experimental projects help to work towards long-term change, fostering learning processes and organizational/institutional change. While policy makers can facilitate certain processes (e.g. create conditions for learning, facilitate vision building exercises and network building), businesses, consumers, academics and NGOs are the ultimate actors who enact the process.

Because this general strategy is a framework strategy, there is variation between countries in concrete implementation. Transition policies are new and 'in the making', there is no 'one best way'. Different countries emphasize particular aspects rather than others. The following section will illustrate this variety in national policy approaches.

Indications of systems thinking in national SCP policies & strategies

A number of European countries are beginning to incorporate a systems thinking approach into their sustainable consumption and production policies and strategies. While it is too early to assess how many of these visions are being translated into practice, it is clear that there is an increasing recognition by policymakers that a more holistic way of thinking and doing must be adopted in order to realise national SCP ambitions.

Austria

An indication of systemic thinking is expressed in the concept for a sustainable Austria:

The transition to sustainable development cannot be limited to individual and gradual improvements, but rather requires a fundamental reorientation in politics, society and economy that comprises all areas of life...As a social process, sustainable development cannot be achieved with standards and technological change alone. It also requires a fundamental shift in values, goals and - as a result - in the behaviour of society with regard to how it faces the challenges of the future (Federal Government of Austria, 2002, 11-12).

(continued)

Belgium

The most recent federal report focuses specifically on the need to adopt a systems thinking approach to realising a transition towards SCP as the key objective for the next national sustainable development strategy (2008-2012):

What would a sustainably developed world look like in 2050? How can we take part in making this sustainable development concrete? Why integrate social, environmental and economic policies?…A good number of our production and consumption activities put a distance between ourselves and sustainable development [translated from Federal Planning Bureau Brochure, 3-4]… A transition is necessary in order to make our current society evolve towards a desired society in 2050, where all objectives [of sustainable development] are met .A transition may be defined as "a social structural evolution, across many phases, resulting in transformations that mutually influence and reinforce each other" [translated from Federal Planning Bureau Full Report, 64].

Czech Republic

Emphasising the strategic objective of changing patterns of consumption and production, the strategy displays a degree of systems thinking in the adoption of the principle of a comprehensive approach which stipulates that:

problems should be dealt with in the context of the whole system of consumption and production, with due regard to individual stages of the life cycle of products and services (Department of Environmental Policies, Czech Republic, 2005, 9).

Finland

The SCP programme, valid until 2025, reflects systems thinking in the comprehensive vision for Finland in 2025:

Finland will base its economy on forms of production that increase national wealth and well-being without depleting biodiversity or exceeding the carrying capacity of natural systems through their environmental impacts… People will have the motivation, opportunity, and access to knowledge to allow them to make choices that support sustainable consumption and production patterns…. New eco-efficient product-service systems, sustainable high-quality products and social innovations will encourage a shift away from the accumulation of material goods to more service-based consumer cultures…A society with sustainable consumption and production patterns will also involve intensified networking and dialogue between different sectors, with environmental and social innovations effectively promoted…(The Committee on Sustainable Consumption and Production, 2005, 3-4).

2 Methodology

A review of the relevant academic literature (incorporating innovation, sustainability and policy studies) was undertaken to identify the key systems thinking concepts and approaches of relevance to SCP policy.

An internet-based search for international examples of new systems thinking in environmental policy was conducted. As suggested in Section 1.9 and illustrated in Section 1.10, such policy thinking is new and 'in the making'. As an emerging approach, there is no 'one best way': different countries emphasize particular aspects over others and those strategies that do incorporate elements of systems thinking are at such an early stage that they are yet to be implemented.

Consequently, there is a paucity of literature currently available on the implementation of systems thinking for SCP – either in terms of academic studies or ex-ante/mid-term/ex-post evaluations. Despite this constraint, three cases were identified that illustrate varying degrees of explicit systems thinking and its implementation: The Dutch Energy Transition Programme of The Netherlands, The Austrian Technologies for Sustainable Development programme, and the Energy2000/SwissEnergy programmes.

As the most advanced example of the implementation of systems thinking in national policymaking to date, the Dutch Transition Programme has been widely discussed in the innovation, and science and technology policy studies literature[3]. As such, it forms a substantial component of this report. Given the limited time and resources available for this research, which was essentially limited to a desk based study complemented by a small number of telephone interviews, identifying further well documented case studies in this emergent policy arena was much more challenging. In light of this, and due to greater difficulty in accessing relevant material, the two additional cases are considerably shorter.

Finally, a dissemination workshop was hosted by Defra on 26 September 2008 to present the key findings of this report to a range of policy and academic stakeholders with an interest in systems thinking for SCP. This event was particularly useful in providing an opportunity to refine and enhance the policy relevance of the report's recommendations.

[3] This was complemented by the expert knowledge of one of the authors regarding the Dutch Energy Transition Programme (F. Geels).

3 The Dutch Energy Transition Programme

Systems thinking and the Energy Transition programme

The Dutch Energy Transition programme exists for 6 years, during which period it evolved from a policy experiment to a more substantial policy programme. The programme is rooted in the Fourth National Environmental Policy Plan (NMP4), issued in 2001, which set out new directions and new ambitions. The NMP4 identified seven large environmental problems of importance for the coming decades[4]. These persistent problems were labelled as 'system faults in the current social order' (VROM, 2001: 11). The NMP4 identified transitions as possible response strategy:

> *To solve the big environmental problems, system innovation is needed which in many cases takes the form of a societal transformation process with technological, economic, social-cultural and institutional changes. The timescale that such transformations require, can be seen as transition. During the transition goals will be formulated and adjusted and mutually reinforcing instruments will be applied. Transitions require a kind of policy approach that recognized uncertainty, complexity and interdependencies. Long-term thinking provides a context for short-term decisions. Influencing transitions requires the government to deal with uncertainties, amongst others by using scenarios, to recognize the international dimension of change processes, and to keep multiple options open (VROM, 2001: 30; translated from Dutch).*

This new policy plan was subsequently elaborated in follow-up plans by the Ministry of Economic Affairs (EA), which is responsible for energy policy. In 2005, this led to a first round of concrete implementation in the form of 'transition platforms' (new stakeholder networks), 'transition visions' (desirable end goals), 'transition pathways' (possible ways to reach the end goals), and 'transition experiments' (concrete projects to explore the pathways and learn about possibilities and barriers). Innovation and real-life learning through concrete projects is seen as central.

The Energy Transition (ET) programme addresses the post-Kyoto period, nurturing the seeds that will help the Netherlands make a transition to a sustainable energy supply by 2050. The ET is explicitly characterized as cooperative multi-actor process, involving business, policy, academia, NGOs and citizens (http://www.senternovem.nl/energietransitie/index.asp). At present, the ET consists of six platforms and themes:

1. New Gas
2. Bio-based Raw Materials (green resources, biomass)
3. Chain Efficiency
4. Sustainable Electricity
5. Sustainable Mobility

[4] These were: 1) loss of biodiversity, 2) climate change, 3) over-exploitation of natural resources, 4) health threats, 5) accidents and insecurity, 6) deterioration of local quality of life (noise, air pollution, lack of green spaces), 7) unpredictable risks (technological, infectious diseases).

6. Energy in the Built Environment

Pre-developments (1989-2001): Policy styles, capabilities, learning, networks and horizontal coordination

Policy style and capabilities

The Netherlands has a tradition of national environmental policy plan. The First Dutch National Environmental Policy Plan (NMP1) in 1989 promoted cleaner technology, environment management systems, and voluntary agreements between state and industry. NMP2 (1993) and NMP3 (1998) contributed to the further institutionalisation of this policy approach. But NMP3 also identified a possible new direction: 'more radical innovation is possible by developing new systems which fulfil the functions of existing systems more efficiently' (VROM, 1998: 246). Policy 'must not be confined to the development of new technology and technological products, [but] must also be directed towards the interrelationship between demand pull and technology push' (VROM, 1998: 246-247).

In sum, the Netherlands has an institutionalized policy style (and capability) of developing and applying strategic plans at the national level, also characterized by a consensual approach to stakeholder involvement.

New networks and policy learning

In the late 1990s, environmental policy began to move away from incremental approaches, contemplating possible systems innovations. This development of new ideas was greatly stimulated by new research-policy networks that had formed through environment-technology research programmes in the 1990s:

- the DTO programme (*Sustainable Technological Development*, 1993-1997)
- the TNO '*81 options' (technology for sustainable development*) project (Weterings *et* al., 1997)
- the EET programme (*Economy, Ecology, Technology*, 1996-2002).
- the NIDO programme (*National Initiative Sustainable Development*, 1999-2004).

These programmes programs were based on the notion of technology development as social innovation process and the added value of (technological) innovation for sustainable development. The DTO programme also contributed to the revival of long-term thinking in environmental policies and introduced the backcasting-scenario methodology (start from a desired future state and then think back on how you can get there) (Quist, 2007). The NIDO programme explicitly cooperated with business in more concrete 'bottom-up' sustainable development initiatives.

These programmes provided sites for dialogue between innovation researchers and policy-makers (Smith and Kern, 2008). They also stimulated the emergence of a research-policy network that articulated new ideas about technology, innovation and sustainability. Recurring ideas were: a) the need for more encompassing change (systems change), b) a long-term orientation, c) a conceptualisation of innovation policy that attends to the social processes involved (not only R&D driven technology push), d) the use of scenarios and back-casting techniques to provide a compass for plotting potential pathways and niche experiments, e) the importance of participatory stakeholder approaches.

Preparing NMP4: Window of opportunity, negotiation, horizontal coordination

In the late 1990s, policy makers increasingly perceived the previous plans as insufficient for decoupling the economy from environmental degradation (VROM, 2001). This dissatisfaction made policy makers more willing to look elsewhere for new concepts and ideas. It thus created a window of opportunity for the ideas that had been elaborated by research-policy networks, described above.

To prepare the upcoming NMP4, the environment and economy ministers convened an interdepartmental working group in 2000. Their brief was to provide ideas for reinvigorating the NMP process.

The NMP4 working group commissioned a report on transitions from innovation studies researchers (a.o. Rotmans, Kemp, Geels). This report summarised and brought together some of the ideas that had been debated in previous years. The VROM people (= Environmental Ministry) in the working group were the strongest supporters of these ideas. The EA people (Economic Affairs) were more sceptical and resistant against adopting what they saw as a 'VROM'-concept. For example, one of the NMP4 members, Peter Aubert, an official for the Ministry of Economic Affairs, was at first very critical towards the transition concept. Gradually, however, he became more positive and evolved into a policy champion within EA.

To test the acceptability of these ideas and create more support, extensive internal dialogues and workshops were organized. These discussions helped in the reframing and fine-tuning of these ideas, which made them more acceptable. The link between 'transitions' and 'innovation' was reinforced to tap into the discourse of EA around business and innovation, e.g. 'innovation systems', 'clusters', 'learning' and 'knowledge flows'. The idea that niche innovations could attract international R&D capital appealed and linked up with the vision of the Netherlands as a knowledge intensive economy and nodal site for global innovation networks. Sustainability transitions and system innovations might thus present business opportunities. Transitions thus suggested a greener version of the knowledge economy, highlighting notions such as:

> *sustainable niches turning into mass markets; evolutionary structural change rather than disruption; attracting international R&D; an enabling government working productively with business (Smith and Kern, 2008).*

This framing of transitions as bottom-up, business led process, without the need for a large legislative programme, appealed to EA. With this support, the NMP4 eventually materialized, institutionalizing a 'transitions approach'.

Elaboration of policy plans (2001-2005)

Because NMP4 was thin on detail, implementation required policy makers to develop more fine-tuned plans, instruments and capabilities. With regards to the Energy Transition, transition ideas moved from the Ministry of VROM to the Ministry of Economic Affairs (responsible for energy), where they were seen as a policy experiment. The implementation of transitions policy in the energy domain generated considerable debate about what it meant in practice. In 2002, EA started the Project Implementation Transition management (PIT), led by senior EA official Hugo

Brouwer. The PIT project followed two tracks: 1) preparation of implementation, 2) a project on “policy renewal”.

1) Preparation of implementation of the Energy Transition programme

The implementation build on a vision of the future, prepared by the working group ‘long-term vision for the energy supply-system’ and articulated in a scenario report ‘Energy and Society in 2050’ (Economic Affairs, 2000). ‘Robust elements’ of a future energy system were identified, which would fit in all four scenarios: biomass (green resources), new gas, energy efficiency and wind-energy. These elements and the Ministry’s ambition to initiate and facilitate the energy transition were described in a report, appropriately titled ‘The journey: Transition to a sustainable energy system’ to highlight its open and uncertain nature (Economic Affairs, 2001).

This report was presented and discussed in internal meetings and working groups, at stakeholder meetings and at a final conference organized by the Ministry. The discussions showed that the choice for the main routes was recognized by the stakeholders and supported by the market. Wind energy was dropped, however, because it was seen as not innovative enough (already established), and replaced chain efficiency (industrial ecology) (Loorbach, 2007).

The Project Implementation Transition management (PIT) subsequently produced a report with process goals that should be realized in the next two years (Economic Affairs, 2003a): a) a long-term vision developed and supported by societal stakeholders as a basis for transition paths, b) commitment to the energy transition by the societal stakeholders, c) for EZ to remove the barriers for transition experiment and meet the stakeholder demands as much as possible, d) a proposal for the organization of knowledge related to the transition, e) further analysis of international developments, f) communication activities in support of the transition, g) a proposal for the next phase.

To engage with stakeholders, the ministry created new networks (called ‘transition platforms’) for the identified transition themes. These platforms should enable and facilitate discussions within the framework of the overall ambition and the context set by the ‘Energy and Society’ scenario. In 2004, EA selected chairpersons (all business leaders) for each platform, who subsequently selected platform members. The platforms were then asked to develop shared visions, transition paths and transition experiments. The visions were mainly aspirational, articulating fairly broad future goals, for instance ‘green resources (biomass) will have replaced 30% of the resources used for our energy supply in 2030’. Subsequently, the platforms translated these goals into a portfolio of concrete ‘transition pathways, i.e. *several* kinds of system innovations which might meet these goals. This was about stimulating variety, not ‘picking the winners’. To make the link to the short-term, the pathways were then translated into concrete projects. These ‘transition experiments’ (innovative projects) practically explore the pathways, and are aimed at *learning* about opportunities and barriers[5]. In a next ‘round’, outcomes should then be used to

[5] In the New gas platform, for instance, six experimental projects were selected: 1) buses on natural gas in the city of Haarlem, 2) liquefied natural gas as substitute for diesel, 3) CO_2 delivery to greenhouses in the horticultural sector, 4) urban transport using compressed natural gas in the north of the Netherlands, 5) heating from biogas in the Polder district in Zeewolde, 6) pilot project on micro-generation in households.

adjust the visions and articulate follow-up projects that build on previous experiences. The platforms produced about 80 ideas, 70 of which were selected as transition experiments by the Ministry.

To support the implementation, the Ministry also created some new instruments. To facilitate the creation of coalitions around concrete experiments, the 'Support Transition Coalitions Fund' was created, which provided €50,000 per coalition for feasibility studies (total budget €1.5 million). Another instrument was the 'Unique Chance Arrangement' that provided financial support and subsidies for concrete projects (total budget €35 million). In order to qualify for support the experiments should: a) be part of an official transition path, b) involve stakeholders in a significant way, c) have explicit learning goals. Both instruments came on top of the regular budget (€173 million) for energy innovation. It is difficult to estimate how much of the total budget has been reoriented towards transition projects, because 're-labelling' occurred with traditional or ongoing projects being reframed as 'transition projects'.

2) Policy renewal

It was clearly recognized that the Energy Transition could not be 'managed' by the government alone, and that dealing with uncertainty, open learning processes and institutional change were important. To address possible new governance challenges and facilitate internal policy learning, a project 'policy renewal' was set up. The Ministry consulted with business and other stakeholders about its possible (new) role. These consultations showed that the Ministry should be trustworthy; manage its own affairs well; be consistent and create greater consistency between different policy domains; be able to bring together parties (match-making); not be too much technology-oriented but find a balance between technology and organization; be a partner of forerunners; offer financial support, and be committed to sustainability (Economic Affairs, 2003b).

In 2005, the Ministry established the Interdepartmental Projectdirectorate Energytransition (IPE) to work on horizontal policy integration. The task of the IPE, which involved 30 civil servants from six ministries, was to improve the 'fit between ongoing policy dossiers and policy conditions for system innovations over the longer term' (Economic Affairs, 2005: 52). The IPE also facilitated the transfer of lessons from the Energy Transition to other policy domains.

As part of policy renewal, the Ministry also took some efforts to address institutional barriers. One example is the Trendsetters' Desk (TD), a government service point to provide innovators in concrete projects with support in the areas of policy and legislation (e.g. addressing problems around permits, legislation and exemptions from regulations).

The different processes led to a gradual change in the Ministry's self-perception, which by 2004 considered itself to be 'the initiator, trailblazer and leader of the energy transition in the Netherlands' (Economic Affairs, 2004: 1). The Ministry felt that the Energy Transition gave new impulses to the innovation system on three dimensions (Economic Affairs, 2004): 1) the process of vision development in the resulted in a shared sense of direction, 2) novel coalitions were formed between parties who were previously antagonists (e.g. coalitions between business and the

environmental movement in the biomass platform), 3) niche markets were being explored for transition paths.

In 2005, a new platform for sustainable mobility was established and in 2006 two more platforms were added (sustainable electricity and the built environment). Table 1 provides an overview of the six platforms and the 26 pathways of the Energy Transition programme.

Theme/platform	Goal/vision	Transition path
New gas	To become the most sustainable gas country in Europe	Decentralized electricity generation
		Energy efficient greenhouses
		Green gas hydrogen
		Clean fossil fuels
Sustainable mobility	Factor 2 reduction of GHG emissions for new vehicles in 2015 and factor 3 reduction for all vehicles in 2030	Hybrid propulsion
		Bio-fuels
		Hydrogen vehicles
		Intelligent transport systems
Green resources	Substitution of 30% of resources for energy by green resources by 2030	Biomass production in NL
		Chains for biomass import
		WISE biomass production
		Synthetic natural gas
		Sustainable chemistry
Chain efficiency	20-30% extra improvement of product chains by 2030	Optimising the waste chain
		Precision farming
		Process intensification
		Multimodal transport
		Clearing house for bulk products
		Symbiosis (closing material loops)
		Micro generation
		Energy efficient paper production
Sustainable electricity supply	To make electricity supply more sustainable	Renewable energy sources
		Decarbonisation and cogeneration
		Electric infrastructure
		Electricity use
Built environment	To accelerate energy improvement programmes and stimulate new innovations	Energy improvements in built environment
		Development and implementation of innovations
		Removal of institutional barriers

Table 1. Platforms, goals and paths in energy transition (Kemp et al, 1998: 322)

Practical implementation (2005-2007)

Transition projects

The first round of 70 projects began in 2005. About €10 million of public money was spend in 2005, €15 million in 2006 and €20 million in 2007, supplemented with equal matching from private partners. Because most projects have a 3-4 year time span, feedback to a second round has not yet occurred.

The selection of the 70 projects was done by the Ministry, based on an evaluation of the proposals from the platforms. The main criteria for funding decisions were market-oriented including: costs and benefits of the experiment, likelihood of business investment, strength of demand, and chances of technical success. The proposed projects were not or far less strongly evaluated on other possible innovation dimensions, e.g. demand-side innovations in user practices, procedural

and institutional change, new business models and other social innovations (Smith and Kern, 2008).

This emphasis was related to the Ministry's desire to achieve concrete results to which they could point in future evaluations. Hence, the primary aim of the first round of projects was stimulating business rather than less tangible outcomes. Because they also wanted to make a rapid start, the first round of projects were relatively close to ongoing developments that (large) companies were already contemplating or working on (Loorbach, 2007). In some cases, projects that were already up and running (because started in other innovation programmes) were incorporated in the Energy Transition programme, e.g. an innovative project with Energy-producing Greenhouses, which had show-case potential.

Learning and networking: Competence Centre for Transitions (CCT)

The concrete projects were complemented by a new organization that facilitated network building and learning *between* the projects. In 2005, the Competence Centre for Transitions (CCT) was established, as a joint initiative of the Ministry of the Environment (VROM), the Knowledge network on System Innovations (academia), the Netherlands Organization for Applied Scientific Research (TNO) and the SenterNovem Agency for sustainable development.

The main objective was to stimulate learning and competence building from a practitioners perspective. The input and reflection of academics are seen as important, but requires translation and further operationalization. While the CCT does facilitate interactions between science and practice, it also emphasises interactions between practitioners themselves and makes attempts at codification of real-life experiences. The CCT thus aims to: "enable transition professionals to develop and transmit their competences in managing successfully sustainable system innovations"[6]. CCT takes a broad view on competences and does not simply focus on success/failure factors or 'tips and tricks'. Instead "we take into account both explicit and 'tacit' knowledge regarding innovation processes, common research tools as well as personal skills, and individual drives and values regarding society and sustainable development" (CCT website).

CCT's target group is a growing community of so-called 'transition professionals', active in, government, business, NGOs or scientific institutions. They may be project leaders, policy advisers, facilitators or appointed 'process monitors'. CCT thus perceives practitioners as 'transition professionals', who have relevant hands-on experience and knowledge. Competence development is thus *not* seen as a one-way from science to practice, but as mutual learning process.

CCT organised several activities:

1) Between 3-10-2005 and 11-12-2007, they organised 10 afternoon-meetings, aimed at debate and exchange (hence called 'deepening sessions'). Each meeting centred on a theme, such as partnerships and networks, monitoring, transition policy tools, set up and running of experiments. Usually one practitioner and one academic

[6] http://www.senternovem.nl/Competentiecentrum_transities/index.asp.

provide kick-off presentations, followed by discussions. The meetings were joined by about 50-60 people (CCT Annual Report).
2) They organised four 1-day national conference (called 'networking days'), with workshops and plenary debates. Above all, these events provided space for people to meet and exchange experiences. About 100 people participated in the last event (30-10-2007).
3) To codify experiences and explicate relevant competences, the CCT published a book (March 2008) titled 'Transition successes: About frontrunners, pioneers and crooked paths' (only available in Dutch). The book makes in-depth analyses of 11 experimental projects, highlighting the roles and experiences of individual innovators. To translate practical experiences, the CCT also publishes 'learning histories' (a method developed at MIT), which are stories that not only articulate success/fail factors, but also address the context and the 'innovation journey'. An ongoing project is the development of a so-called 'competence kit', which is not a recipe book ('how to '), but an attempt to articulate relevant competences of successful transition practitioners (explicit knowledge and tacit skills).
4) The development of monitoring and evaluation tools for transition projects. Because transition projects are more innovative, less predictable and more oriented towards learning and network building, these monitoring and evaluation tools should be different from normal project evaluation tools, which highlight progress, performance and efficiency. The CCT is currently developing these tools and trying them out in practice.

Vertical (high level) support
To enhance the visibility and legitimacy of the Energy Transition, a Taskforce Energy Transition was created in 2005, with 15 high-level representatives from science, business, NGOs and the government. Large companies had a strong presence (Shell, Essent, Electrabel, Gasunie). The Taskforce, chaired by Rein Willems (CEO of Shell Netherlands) was asked to define a shared direction, and stimulate the impact of the energy transition.

In 2005, the Taskforce exerted substantial influence on the selection of the pathways and experiments, emphasizing the importance of business potential. In 2006, the Taskforce developed a 'Transition Action Plan', titled *More with Energy: Opportunities for the Netherlands* (Taskforce Energy Transition, 2006). This report, which focused on economic and business opportunities, enhanced the legitimacy of the Energy Transition programme, and generated much publicity. The Taskforce also argued for a substantial increase in government investments in sustainable energy (an additional €1 billion per year). But to some extent, the report also toned down some of the structural change ambitions, stating that fossil resources would remain dominant until 2050. Nevertheless, CO_2 emissions could be reduced with 50% by the gradual expansion of renewable energy, increased energy efficiency, and clean fossil fuel technologies.

Evaluation of strengths and weaknesses

Overall assessment:
Between 2001 and 2007, the Energy Transition programme evolved from a new policy experiment to an institutionalized discourse. In 2001, the NMP4 articulated new ambitions for environmental policy, focusing on several structural problems and the need for system changes or transitions. The NMP4 also explicitly linked

environmental policy with innovation, and recognized the multi-dimensionality of the required change process. The implementation of these ideas in the Energy Transition programme, and thus their transfer to the Ministry of Economic Affairs, initially encountered scepticism, leading to modest framing of the programme as 'policy experiment'. Since then, a wide range of internal and external processes led to more enthusiasm and support. By now, notions of transitions (and many new concepts such as niche, regime, platform, pathway, experiment) are widely recognized and accepted. The Energy Transition (ET) programme galvanized and focused many activities, although these still have a bottom-up character, with limited impact on broader policies and existing regimes. Furthermore, several NMP4 ideas around systems innovation have been watered down during their implementation, e.g. less multidimensionality, more focus on technology and business, somewhat limited stakeholder involvement. So, compared to initial ambitions, achievements are somewhat ambivalent. The advocates of 'transition management', who were closely involved in the Energy Transition (ET) as academic consultants, observe that the energy transition process has:

> *created a new discourse, framework and orientation which is widely supported. Nevertheless, it is not the open, reflexive process it was supposed to be. (…) There has been little cooperation between the platforms or mutual learning. It has not become politically salient in Parliament and society is not really involved in it. (Kemp, Rotmans and Loorbach, 2007: 327).*

Networks

A clear strength of the programme is that it has created many new networks. At the level of concrete projects, several hundreds of practitioners are involved in the ET programme. Many new coalitions have been formed around the project, especially alliances between different businesses and technology developers, sometimes complemented with researchers and NGOs. The Competence Centre for Transitions played an important role in building broader networks *between* the projects.

New networks have also formed at the level of transition platforms, where multiple stakeholders engaged in more strategic debates about possible futures of different areas. In all platforms, however, business and domain-specific researchers were the dominant groups (Table 2).

Platform	Government	Business	NGOs	Intermediaries[7]	Science	Total
Green resources	1	6	1	1	6	15
New gas	1	6	1	1	3	12
Chain efficiency	1	6	0	1	3	11
Sustainable mobility	3	10	3	0	0	16
Sustainable electricity	1	3	0	0	3	7
Built environment	0	4	4	2	1	11

Table 2: Participation in energy transition platforms (Kemp et al., 2007: 325)

[7] The category *Intermediaries* encompasses representatives from municipalities, SenterNovem (excluding the secretaries), the provinces, regional initiatives (such as Rijnmond) or national advisory boards such as Socio-Economic Council (SER).

The main weakness is that the networks, both at the project and platform level, are not evenly balanced. Outsiders are scarcely involved. Regime actors (business, technology developers and energy specialists) dominate the networks. There was little or no space for outsiders, frontrunners, pioneers, out-of-the-box thinkers etc. Although a few NGOs were involved in some platforms, civil society, consumers, the wider public and other actors (such as SMEs) were not involved. Demand-side issues and wider issues of societal embedding are not addressed in a substantial way. The initial participatory and multi-stakeholder intentions have thus not been fully realized.

Learning processes

One strength of the ET programme is that a great deal of (internal) policy learning has occurred within the Ministries involved (new self-perceptions, instruments, teams, policy plans, sub-departments, inter-departmental structures). Another strength is that new institutions have been created that provide ongoing opportunities for dialogue and policy learning. The transitions competence centre, for instance, facilitates learning and debate between the research and policy community. The third strength is that much has been learned about technical and economic aspects of particular innovations and transition paths.

But the techno-economic focus has also led to several weaknesses. While projects were initially intended to facilitate open search and learning processes, they were gradually reframed as a means to create new business. While new business creation *is* an important aspect of transitions, the ambition was that this would have a long-term and strategic character, aimed at opening up new (sustainable) sectors. Instead, the projects tended to focus more on short-term concrete results and tangible output than on open experimentation. A related weakness is that most projects are fairly close to the existing regime, instead of exploring radical innovation.

> *The transition experiments are very technological by nature; they hardly aim at institutional or cultural change. They consist of rather low-risk projects primarily related to CO_2 reduction (Kemp et al., 2007: 326).*

Third, there was little multi-dimensional learning. The focus on business and technology limited the attention for behavioural, institutional, structural and cultural changes. Attention for institutional issues was modest and only oriented towards barriers for innovators (the Trendsetters' Desk). There was no civic debate (for instance about goals and pathways) and citizens/consumers were not involved. The ET programme thus became fairly technocratic and similar to regular innovation policy. This reframing was related to the social network composition discussed above.

Visions

Although the learning processes have some characteristics of traditional technology-driven R&D policy, the ET programme positioned them in a long-term sustainability orientation. Visions were important, both in the beginning (the 'Energy and Society' scenario study) and in the platforms. But the enactment of visioning and the use of scenarios also had some weaknesses.

First, the 'Energy and Society' scenario was not participatory, but done by 'experts'. The scenarios consisted of *forecasting* scenario exercises based extrapolation of present day trends. The scenarios did *not* produce very innovative, inspiring, imaginary futures that could be used for backcasting and thinking about (desirable) radical changes (Loorbach, 2007).

Second, the Ministry imposed these scenarios on the transition platforms, to be used as framework conditions for the platform's own interactive vision articulation and discussion. This constrained the scope and breath of the platform's visions. The demarcation of the issue, the problem framing and selection of the main themes/platforms was done by the Ministry itself. This led to a strong focus on CO_2 reduction, with little attention for other possible sustainability aspects.

Third, the goals of the platforms visions are quite broad. Hence, they provide little real guidance, but act more as a wide umbrella. This led to broad portfolio of pathways, which includes almost all sustainable technologies (except solar photovoltaic[8]). This helped to create acceptance amongst vested interests (most of which are involved). But it also created a lack of focus and dilution of resources.

Horizontal coordination

There was attention for horizontal integration, in the form of the Interdepartmental Projectdirectorate Energytransition (IPE). The strength was that the ideas and discourse of transitions *did* diffuse to other Ministries, some which have set up their own transition programmes (Transport, and Agriculture). But real coordination and alignment of policies in other sectors to the Energy Transition programme has not (yet) occurred.

Vertical (high-level) support

The first couple of years, the ET programme remained a niche within the Ministry. The involvement of the high-level Taskforce Energy Transition (in 2005 and 2006) stimulated wider diffusion and acceptance, both within the Ministry and in the energy sector more widely. The Taskforce raised the profile of the Energy Transition and its legitimacy.

On the other hand, the Taskforce consisted mainly of regime players who to some extent defend their own interests, e.g. by toning down the structural change ambitions. The Taskforce also was influential in reframing the Energy Transition processes in terms of business opportunities (at the expense of other dimensions). And it influenced the choice of pathways and experiments by putting pressure on actors in transition platforms, which was at odds with the participatory ambitions.

Alignment with regime pressure

The ET programme has *not* been complemented by policies that create pressure on the existing regime (the two pronged approach described in the introduction).

> *So far, the attention for transitions has not resulted in changes in fiscal policies or in environmental policies that will be needed to change the energy supply system. (…) No*

[8] To 'repair' this problem the sun-PV innovation network lobbied the government, and was able to secure funds through a special parallel programme.

plans are being made to phase out unsustainable energy technologies (Kemp et al., 327).

Hence, it has remained a bottom-up programme with a focus on experiments and projects. The influence on wider energy policy at the regime level (e.g. regulations, energy markets, product standards, user behavior, infrastructure renewal) has been limited (so far). No fundamental questions have been raised regarding the current regime, consumption, dependence, equity or power. Regime level windows of opportunity for wider diffusion have thus not been created.

4 The Austrian Programme on Technologies for Sustainable Development

Programmatic aspirations and visions: Multi-dimensional systems thinking

The second (shorter) case is the Austrian 'Technologies for Sustainable Development' Programme (ATSD). ATSD is a national initiative that focuses specifically on the integration of innovation and environmental aims. Launched in 1999, the programme seeks to support the development of future-oriented innovations to pursue sustained economic growth without negative effects on the environment. ATSD has been chosen as a case study because its *aspirations* express systemic thinking and the need for radical change spanning consumption and production:

> *Only an economy based on the principles of sustainability will be able to secure our prosperity and quality of life in the long run. This, however, requires a radically reduced consumption of resources, which, in turn, can be achieved only by a fundamental change in our way of life and our economy*[9]*.*

In terms of guiding principles, ATSD explicitly recognizes that technological change is insufficient for systems change, although clearly an important element. ATSD therefore distinguishes the need for three types of interrelated innovations:

> *Crucial to this [aim] is the exploration of innovations on the following three levels:*
> - *Structural innovations: changes in structure and systems, system behaviour, basic conditions*
> - *Social innovations: changes in user behaviour dependent on knowledge, attitudes and lifestyle*
> - *Technological innovations: developments in key areas of the entire spectrum from primary energy sources to energy services*[10]

To facilitate these inter-related innovations, ATSD aims at interdisciplinarity and networking between individual research projects, implementation of exemplary pilot projects and appropriate (multi-dimensional) project management.

Implementation

ATSD consists of three sub-programmes: I) 'Energy Systems of Tomorrow', II) the 'Factory of Tomorrow' and III) the 'Building of Tomorrow'. All sub-programmes consisted of many innovation and pilot projects. The 'Energy Systems of Tomorrow', for instance, ran 51 projects in the first call (2003-2004), which received a total of 5.9 million euros. For the second call (2005-2007) funding statistics and numbers of projects are unavailable. To get deeper inside the sub-programmes we discuss two projects from two of the sub-programmes: 1) 'Energy Regions' and 2) 'Transitions to Sustainable Production Systems', focusing in particular on process dimensions.

[9] www.nachhaltigwirtschaften.at/english/index.html
[10] www.nachhaltigwirtschaften.at/english/index.html

The ‘Energy Regions’ project refers to “regional, energy policy-related initiatives aiming to implement innovative forms of energy supply and/or to change consumption patterns which often involve participatory processes of target setting” (Spath, 2006, 1). Such initiatives are typically driven by regional stakeholders who feel that both market mechanisms and the incumbent political system are unable to facilitate a transition to a more sustainable energy system. These ‘think global - act local’ initiatives are thus strong in *network building*, an important niche-innovation process (see section 1.7). Although the initiatives want to be forerunners, they also “welcome to be imitated” (Spath, 2006, 12), thus facilitating mutual *learning processes* (section 1.6) by exchanging experiences. The regional initiatives also work on the *articulation of visions* (section 1.8). The typical process of ‘Energy Regions’ is for a group of stakeholders to define “a set of shared long- or medium term objectives related to energy and institutionalise it in some kind of manifesto that shall provide an orientation for diverse regional actors (be it policy makers, companies and/or households) and hence allow for a co-ordination of their respective actions” (Spath, 2006, 1-2).

A strength of ‘Energy Regions’ is the proximity and face-to-face interaction in the social networks. Regional actors (companies; policy makers; energy activists; larger parts of the regional population) are close to each other and can build tight innovation networks based around a consensual vision of shifts towards more sustainable energy systems, while also seeking to enhance their own regions’ economies and environment.

The ‘Energy Regions’ therefore represent a number of region-specific niches that enable experimentation and learning processes with a number of cutting-edge renewable energy technologies (e.g. biogas, biomass, hydro/solar/wind powers) and their embedding in specific social contexts. They also provide test-beds for more co-operative and network-based forms of governance. Finally, they are “interesting attempts to synchronize expectations and align actors and resources in novel arenas of public deliberation, which strategically - and in many ways successfully - craft a ‘consensus’ on…change” (Spath, 2007, 1).

‘Transition to Sustainable Production Systems’ was a strategic research project “to establish a platform to *reflect upon strategies to shape a transition towards sustainable production-consumption systems”* (Späth et al., 2004, 3). It was an experiment to integrate and implement research carried out in the ‘Factory of Tomorrow’ programme. It also intended to embed diverse projects in broader transition strategies and to promote greater coherence and interaction amongst programme and project stakeholders.

The project focused on three substantive domains: bio-refineries, sustainable dyeing and wood as a structural material for construction. The project used participatory scenario-building exercises to bring together stakeholders in each of the three domains (programme managers, project participants, firms and other interest groups). These exercises achieved a number of process aims:

- situating stakeholder interests and activities in a wider system context;
- facilitating the building of networks amongst stakeholders with an interest in the further development of their respective domain;

- establishing a common vision and platform for a transition towards a more sustainable system;
- changing stakeholder perceptions with regards to the framework conditions necessary to realise this vision, and their collective research priorities and strategies to link up to these conditions.

The project thus attempted to introduce systems thinking (and greater coherence and consensus). To facilitate vertical linking and provide support, the project established a high-level board of advisers (with members from the Austrian Federal Ministry of Transport, Innovation and Technology; programme management; the Austrian Research Council; an external expert).

Analysis and Evaluation

One strength of the ATSD programme is that concrete projects, such as the ones described above, provide space for three processes that are important in the development of niche-innovations (sections 1.6, 1.7, 1.8): 1) they enable learning processes, 2) they enable actors to develop shared expectations and visions, 3) they facilitate network building, social interactions, and the exchange of experiences.

Another strength is that the programme, at least in terms of aspirations, aims to go beyond 'traditional' technology and R&D focused innovation programs. In that sense, it represents a learning process with innovation policy for sustainability moving towards new modes of systems thinking. There is a clear desire to learn about and experiment with systems thinking.

A weakness is that the practical implementation in terms of projects is to a large extent disconnected from the ambitious programmatic aspirations. While there are exceptions (such as the two projects described above), most concrete projects turned out to be predominantly technology-focused. From the 51 projects in the first call of the 'Energy Systems of Tomorrow' programme, only a few are multi-disciplinary and multi-dimensional. Most projects reported on the website consist of technical R&D projects, in which innovations either do not leave the lab or address only technical dimensions in real-life test situations (ignoring the social and structural dimensions explicitly mentioned in the programme's statements). Practical implementation thus seems to lead to a watering down of the initial ambitions, with technological development taking centre stage.

Three causes contribute to this problem. First, the programme lacked an intermediate level that bridges generic aspirations and concrete social and technological innovations (Weber et al., 2003, 2). This intermediate level should be focused on the development of ideas and visions about:

> *systemic solutions for ensuring the provision of certain functionalities. (…) where specific technologies are tied together with and embedded in social and organisational practices in order to offer an alternative solution for providing a functionality needed.*

So, the ATSD programme started not from the social functions that should be fulfilled but from the technological options that were available.

Second, some of the sub-programmes were defined too broadly, leading to lack of focus. This applies particularly to the 'Factory of Tomorrow' programme, which addressed the broad and heterogeneous area of 'production'. This broad area consists of a number of production-consumption systems and spans a range of activities (from resource extraction through production chains to final consumption). Given this lack of focus, it was difficult to evaluate how certain projects contribute to the programme aims. If evaluation criteria are unclear, there is scope for technology-focused product champions to claim that their projects fit well. Hence, Weber et al. (2003, 2) suggest that:

> *in…operational terms, there is a need to assess individual projects with respect to sustainability and a transition path. At programme level this requires corresponding assessment and selection criteria to be in place.*

Third, the ATSD programme made extensive use of experts from the technology fields involved. The proposed projects therefore turned out to be much in tune with the research agendas of the people in the field, but less well connected to demands, concerns, and preferences of wider stakeholders, who could have brought in the social, institutional and structural dimensions of systems change. The network composition thus greatly influenced the project selection, a conclusion that also emerged from the Dutch case.

5 The Energy 2000 / SwissEnergy Programmes

General characteristics and ambitions of two energy policy programmes

The third (also short) case is about two ambitious policy programmes in Switzerland: 1) the Energy 2000 Action Plan (1991-2000) and 2) its successor SwissEnergy (since 2001). Swiss energy policy is characterised by *strong vertical policy linkages*, based on a framework that incorporates top-down initiatives and bottom-up engagement. *Top-down* initiatives include:

- The Federal Energy Act (1998) - ensures that the government meets its obligations to "provide an adequate and secure energy mix that is economically as well as environmentally sound" (Swiss Confederation, 2005, 79).
- The CO2 Act (2000) - stipulates an overall 10% reduction in CO2 emissions by 2010 based on 1990 levels.

Conditions that facilitate *bottom-up* engagement include:

- A strongly localized tradition of cantons where "governmental action is devolved to the lowest possible level at which it can effectively be carried out" (International Energy Agency, 2003, 23). Hence, "the cantons elaborate their own energy policies (e.g. regarding the promotion of renewables or energy efficiency) whenever legislation does not specifically transfer the competence to the federal government" (Madlener, 2006, 2).
- An emphasis on the use of voluntary measures as much as possible in order to promote and enhance cooperation between the state and industry.
- Direct democracy, whereby citizens have the right to referendum and influence local, cantonal and federal policies (Madlener, 2006, 2).

Because of these vertical linkages, Swiss energy policy is characterized by a combination of *regulatory instruments* (mainly in terms of legally binding Acts that articulate ambitions and provide framework conditions) and *process-based implementation* (at local canton level), which is further discussed below. The energy policy programmes provide an intermediate level. The ambition of the Energy 2000 Action Plan (1991-2000), which implemented national energy policy, was to stabilise both electricity consumption and the use of fossil fuels (and hence CO_2 emissions) by 2000 and to reduce the latter thereafter[11]. Energy2000 represented systems thinking because these goals were fairly radical and because it was based on process-oriented guiding principles: dialogue with interest groups and other stakeholders, the use of state framework conditions which local actors themselves had to elaborate, and voluntary measures.

Its successor, SwissEnergy, was launched in January 2001 and labelled as a "platform for an intelligent energy policy" (Meyer, 2003, 9)[12]. SwissEnergy enforces the Federal Energy Act (1998) and CO_2 Act (2000), and has more focused and updated objectives to reduce the consumption of fossil fuels, to slow down the growth of electricity demand and to increase the contribution of renewables to

[11] A total of SF 558 million was allocated to the programme for its duration, most of which was directed towards the promotion of voluntary actions.
[12] The average annual budget is SF 55 million.

energy supply. Since 2005, SwissEnergy has been optimised and adapted to become more impact-oriented and efficient, focusing on five areas:

- Modernisation of buildings
- Renewable energy
- Energy-efficient appliances and motors
- Efficient use of energy and waste heat throughout the economy
- Energy-efficient and low-emission mobility

While a large number of projects across these areas are funded under the programme, the following initiatives are seen by programme management as being the most significant (as reflected in their prominence in programme literature)[13]:

- Energho – an association of major energy consumers in the public sector which assists cantons in their efforts to improve energy efficiency in public buildings.
- Minergie – a quality standard that seeks to promote low energy consumption in new and renovated buildings through clearly defined and monitored technical specifications.
- Eco-Drive – a special course for economical and ecological driving behaviour.
- Energy City – see evaluation section below.

Process dimensions of implementation

The implementation of the two energy programmes has paid much attention to process dimensions, particularly to: 1) network building, 2) multi-stakeholder communication strategies, and 3) the management of stakeholder expectations.

1) building of *social networks* was important in both Energy 2000 and SwissEnergy. *Coordination through partnership* across the different levels of the Confederation, cantons and communes is a key strength. Collaboration between policy, industry, investors and consumers is seen as important, because all these social groups directly influence energy use.

Specific activities and instruments were developed to facilitate network processes. Energy2000, for instance, piloted the use of so-called 'Energy Patrols', which created knowledgeable intermediaries (typically engineers and/or active energy advisers with relevant technical knowledge and sales skills) who helped establish links between buyers and suppliers of Energy2000 measures (or products) that increased energy efficiency (e.g. energy accounting). In 1996, a network of 20 intermediaries was created, each assigned to a specific region. The network of regionally-based intermediaries helped to bring potential customers into direct contact with Energy2000 trade products. This approach proved to be successful in stimulating the diffusion of energy efficient products (Hennicke et al., 1998).

SwissEnergy, in turn, was explicitly based on a number of explicated principles regarding network building activities:

[13] A project database is available on the SwissEnergy website but the database is almost entirely in German. Consequently, information relating to the development of specific innovations in niche-based experiments is unavailable.

- *Communication must take place in all directions, from top-down to bottom-up, but also between partners.*
- *Collaboration will take place among all actors, whether on a specific theme or on questions of a more general nature.*
- *Links will be consciously established between the levels of Confederation, communes and cantons.*
- *New partnerships will be sought, notably in the marketplace, with environmental organisations and among decision-makers and other influential persons outside of the energy arena. All possible synergies will be exploited* (translated from SuisseEnergie, 2005, 20).

2) *Communication* has been always central to Swiss energy policy and programmes (Hennicke et al., 1998). In 2006, SwissEnergy launched a new communications strategy that linked communication, shared visions and network building. The aim was to stimulate the build-up of a common identity based on the vision of working together towards a more sustainable energy system.

> *SwissEnergy (…) has to ensure that the many players* ***have one thing in common****: despite the number and variety of intelligent energy solutions they represent, it is important to make it clear* ***they are part of SwissEnergy****, whether in the area of mobility, in buildings, in a factory or in a farmyard. The aim…is to demonstrate to investors, companies, tradesmen, house owners, tenants, architects and consumers that* ***they can all contribute*** *towards a future sustainable energy supply (translated from SuisseEnergie, 2006*[14]*; emphasis added).*

The communication strategy thus tries to develop a sense of collective enterprise and shared mission in the sustainable energy transition. Such public support and engagement enhances the legitimacy of the journey.

3) There are explicit attempts to manage potentially conflicting *expectations* and proactively seek consensus. In general, the implementation of radical innovations, especially large-scale projects, is easily delayed or blocked by social groups who feel they have not been involved in the decision-making process (especially in countries with strong democratic traditions and many legal delaying options). To prevent social resistance and opposition during the implementation phase, stakeholders are better involved earlier in the process. In that respect, Energy 2000 developed the method of 'conflict-solving groups' (Hennicke et al., 1998). A project that aimed to expand hydroelectric power in a particular area used this method to facilitate interactions between antagonistic stakeholders. For 2½ years, a conflict-solving group was used, with representatives from the electricity industry, environmental organisations, the federal government and the cantons. A mediator facilitated the interactions which were aimed at early negotiation of a range of issues: technical designs, licensing procedures, demand, maintenance/operation issues. Multiple rounds of interactions and dialogues gradually led to mutual understanding and respect between 'former' enemies. Because the iterative process of investigation and negotiation allowed early involvement of stakeholders, these actors refrained from opposition in a later stage, which facilitated implementation of further hydroelectric expansion.

[14] www.bfe.admin.ch/energie/index.html?lang=en

Analysis and evaluation

Overall, the Swiss energy programmes are seen as a success in realising a number of ambitious goals. Without the programmes, CO2 emissions would be approximately 2.8 million tonnes higher than present-day levels; the consumption of fossil fuels would be approximately 7.9% higher; and overall electricity consumption would be around 4.7 percent higher than the current level[15]. The programmes have therefore significantly improved energy efficiency and significantly increased the proportion of renewable energy.

One reason for how this success has been achievied is by "means of an ambitious regulatory approach combined with rigorous enforcement, strong support from the public and a considerable financial effort" (OECD, 1998, 2). However, offsetting this is an imbalance in the sets of regulatory, economic and voluntary measures used. In particular, the use of economic instruments is comparatively modest compared to other OECD countries. There is agreement that the use of such instruments should be further expanded in order to exert greater pressure on the energy regime (such pressure is also lacking in the Dutch case), which cannot be achieved through an over-reliance on voluntary measures. More specifically, economic instruments could help to: increase efficiency in the energy markets; reduce energy consumption and emissions; and internalise the externalities of energy transformation and use (International Energy Agency, 2003, 10; OECD, 2007, 2).

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In spite of this weakness, the Swiss energy programmes are particularly notable for their drawing on the *strong vertical policy linkages* that create a framework incorporating top-down initiatives and bottom-up engagement. This is reflected in the case of the 'Energy City' label. This label is "awarded to cities that have an active and effective energy policy. To attain energy city status, an energy programme with binding objectives, deadlines and budgets is essential, as is a suitable list of measures, the effects of which must be quantified and documented" (Swiss Agency for the Environment, Forests and Landscape, 2001,34). So far, 128 energy cities have been awarded the label – representing 2.2 million inhabitants or approximately 30% of the Swiss population.

In contrast to the Austrian case, there is little rhetoric about explicit system thinking in the Swiss energy programmes. However, as illustrated in the previous section, there is clear evidence of systems thinking in the process implementation of the programmes. The examples show that *network-building*, *multiple stakeholder engagement* and managing stakeholder *expectations* are all central to the programmes' activities at strategic and operational levels.

[15] www.bfe.admin.ch/energie/index.html?lang=en

6 Conclusions

This project has shown the emergence in European academic and policy circles of new systems thinking about the dynamics of innovation for sustainable consumption and production. At its heart is a recognition of the systemic nature of new, long-term, global sustainability challenges such as climate change. This requires transitions in the systems that fulfil key societal needs like mobility, shelter, food and energy.

The facilitation of such systemic innovation is different to the traditional management of singular technological innovations in several respects. It needs to enable the co-evolution of technological and behavioural change, the involvement of diverse stakeholders representing demand as well as supply, the spanning of different scales of activity, and the bridging of long-term visions to near-term action.

The rise of interest in systemic thinking has focused attention on the interface between 'environmental policy' and 'innovation policy'. Bringing together these traditionally disparate domains of policy requires a new emphasis on radical systemic change for explicit societal goals of sustainability.

The study shows the emergence of a range of interesting examples of systems thinking in a number of European countries. It is a policy approach which is still very much 'in the making'. Practical experience is being gathered which can provide a preliminary basis for learning, though it is too early to identify best practice.

The cases revealed different starting points for policy reform, not necessarily from within the sustainable production and consumption policy sphere. In the Netherlands case it originated from environmental policy with broad systems ambitions. In the Austrian case it started from innovation policy through the addition of systemic elements. In the Swiss case it emerged from national energy policy reform.

The cases showed a similar tendency to result in rather technology-oriented innovation programmes despite the original intentions. Initial aspirations may be highly systemic in terms of radical change and multi-dimensionality but implementation tends to end up with technology-focus. Although not unusual in policy innovation, it does appear to be the case that the narrowness of networks involved in both the Dutch and Austrian cases may have contributed to this outcome. This suggests that attempts to move to a more systemic policy approach may face barriers in terms of institutional inertia.

The policy blend between fostering new niches and pressuring existing regimes varies between cases. In the Netherlands the focus on innovative niches was not complemented with regulatory or economic pressure on regimes. In Switzerland the substantial regulatory pressure on the regime was accompanied by moderate niche-oriented measures. Austria seems mainly focused on niche support policy.

The development of systems thinking in policy requires new policy capabilities for scoping and network building. Although these are sometimes able to draw on

existing in-house expertise they often need new networks between policy makers and innovation academics as shown in both the Netherlands and Austria to articulate new ideas. One of the outcomes in the Netherlands case was also the creation of a new competence centre. Such novel capability building initiatives will be a necessary accompaniment to such a new policy orientation.

Systems thinking has led to the exploration of a variety of new policy instruments addressing 3 systemic issues: **networks**, **expectations** and **learning**. Elaborated fullest in The Netherlands' transition programme, they are also evident in the other national cases investigated. System innovation is about change initiated by emergent actors which is initially expressed through niches outside of the mainstream. Traditional innovation is oriented towards the improvement of existing products and services. System-changing innovations initially appear marginal in terms of cost and performance and lack a developed market. To support them requires policy approaches sensitive to their needs.

Networks

Network instruments include transition platforms in the Netherlands and conflict-solving groups in Switzerland. System innovation needs broad networks which include emergent entrepreneurs and demand-oriented social innovators in addition to incumbent businesses and supply-oriented technical experts.

Policies need to facilitate such networks. In order for them to flourish and fulfil their potential it may be preferable to build on existing networks rather than simply start from scratch. However, as shown by The Netherlands case, institutional inertia may limit attempts at network building more narrowly to incumbents and technical experts. Some degree of institutional innovation may therefore be required to overcome such inertia.

Network building processes are not necessarily harmonious, and often involve tensions, disagreements, power struggles, etc. Network building requires a great deal of sensitivity and political capital if it is to be effective and often this competence is lacking. In some cases there is a need to facilitate the emergence of new intermediaries such as the Energy Patrols in the Swiss case.

Expectations

New instruments introduced to address social expectations include scenario building in the Netherlands and new communication strategies in Switzerland aimed at creating sense of shared mission. System innovation needs visions of the future which step outside the usual contemporary framing of a problem and also relate that longer term future to near term opportunities. The way in which these expectations are created and shared plays a key role in enabling long-term radical change.

An important approach to expectations is to frame the problem in a consumption-oriented fashion around the fulfilment of a societal need without any preconditions about technology or business sector. This is illustrated by the 'Sustainable Mobility' platform in the Netherlands and the 'Building of Tomorrow' programme in Austria framed around mobility and shelter. This is clearly a problem that needs deeper

understanding as to how to successfully change the terms in which expectations are discussed yet still retain a connection to current sets of actors whose identity may be wrapped up in fields of technical specialism or sectoral interests.

Participative foresight methods seem more helpful than reliance on expert forecasting or predictive approaches. The Netherlands case shows the difficulty of overcoming existing policy predispositions in order to achieve this. Participative methods overlap with the aim of broad network creation. Stakeholder-led approaches which work with multiple scenarios and visions of the future can both build consensus on shared goals and help to manage conflict and diversity.

Learning

New policy instruments have been designed to facilitate effective learning about the prospects and problems of different pathways with the potential of system transformation. Described in the Netherlands as transition experiments or sociotechnical experiments they embrace social as well as technological innovation. This is different from the learning in an R&D project or even a technical demonstration project. It is much more oriented towards cultural and consumer changes than being confined to technical feasibility. The Energy Regions in the Austrian case locate this learning process in a local spatial context.

'Learning by doing' is the philosophy which underpins these new instruments. This offers a different bridge over the 'valley of death' than go/no go investment decisions based on traditional technical feasibility projects or economic cost/benefit evidence based methods. Instead there is a commitment to invest in exploration and prototyping in a social setting limited by space or scale.

Since the future is unknown it is important to retain a diverse portfolio of sociotechnical experiments and path exploration rather than be too selective, too early. Significant investment is required if such diversity is to be supported over time and as experiments move closer towards the market. The country case studies show the difficulty of promoting this different orientation and how traditional supply side policy orientation encourages a reversion to the R&D project model.

Policy Integration

The cases show that system-oriented policy instruments do not fit easily into existing institutional and departmental frameworks. New vertical and horizontal policy integration is needed for a favourable and supportive context to enable system-oriented policy instruments to thrive. The absence of effective boundary spanning between environment and innovation policies is shown to be a highly significant factor in the Netherlands and Austrian cases. Similar issues affect the coordination across different functional policy areas (energy, agriculture & food, transport, construction, planning, economic development, etc.) and between different levels of governance (from the local and regional, through to national and European / international). The Netherlands case shows attempts to build an Interdepartmental Transitions Directorate and Trendsetters Desk to address this. It is clear that significant resources, combined with cross-functional SCP champions and the requisite policy capacity to facilitate such coordination is critical to success.

Going Forward

The growing recognition of the importance of systems thinking, and the experience gained so far in the cases analysed, suggest that it would be useful if the UK contributed to the exploration of this approach. In comparison with the countries investigated, the UK has well developed policies using market-based instruments to apply pressure to the prevailing unsustainable regime. However, system-oriented policies for the promotion and nurturing of new sustainable niches are less developed

The UK SCP Programme is well placed to use its existing international contacts and networks to monitor emerging attempts to introduce systems thinking within other national SCP programmes.

Although initiatives to promote systems thinking for SCP at a UK level will clearly require inter-departmental 'buy in' and collaboration across government, Defra should in the first instance take a lead in promoting systems-oriented policy innovation and experimentation within its own SCP programme.

An initial way forward could involve the following:

- Convening an international workshop on systems innovation and SCP policy to share emerging thinking, review national experiences and identify opportunities for future collaboration and joint initiatives

- The establishment of a systems innovation capability building network comprising UK policy makers, academics and entrepreneurs involving a learning partnership with the Netherlands Transition Competence Centre.

- Identifying priority areas within the SCP Programme's policy domain where experimentation with systems-oriented initiatives might add value. For example, exploring options for: i) radically reducing resource use and waste; or ii) consumer behaviour and sustainable food systems.

In addition:

- The SCP Programme should take a lead in promoting dialogue on systems thinking and transitions-oriented policy approaches with key stakeholders across government, such as the Sustainable Development Commission, BERR and the Technology Strategy Board. This could be done with a view to creating an interdepartmental systems thinking 'think-tank' made up of relevant representatives and spearheaded by Defra. The think-tank would serve as a means to promote horizontal collaboration across a range of policy areas with an interest in or responsibility for SCP.

- Longer term, Defra, CLG, the new Department for Energy and Climate Change and others should consider the creation of a system-oriented 'platform' or 'arena' in collaboration with an agency concerned with innovation policy such as the Technology Strategy Board.

- The theme for such a ‘platform’ or ‘arena’ should avoid a specific technological area. Rather, it should focus on a topic such as the low carbon ‘household’, ‘neighbourhood’ or ‘community’. This would take advantage of the development of UK policies such as the Climate Change Bill which are exerting pressure on the carbon-based regime by supplementing it with a new niche-oriented systemic policy initiative.

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