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article:

more evolution than revolution: *transition management in public policy*

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Transitions are transformation processes in which society changes in a fundamental way over a generation or more. Although the goals of a transition are ultimately chosen by society, governments can play a role in bringing about structural change in a stepwise manner. Their management involves sensitivity to existing dynamics and regular adjustment of goals to overcome the conflict between long-term ambition and short-term concerns. This article uses the example of a transition to a low emission energy supply in the Netherlands to argue that transition management provides a basis for coherence and consistency in public policy and can be the spur to sustainable development.

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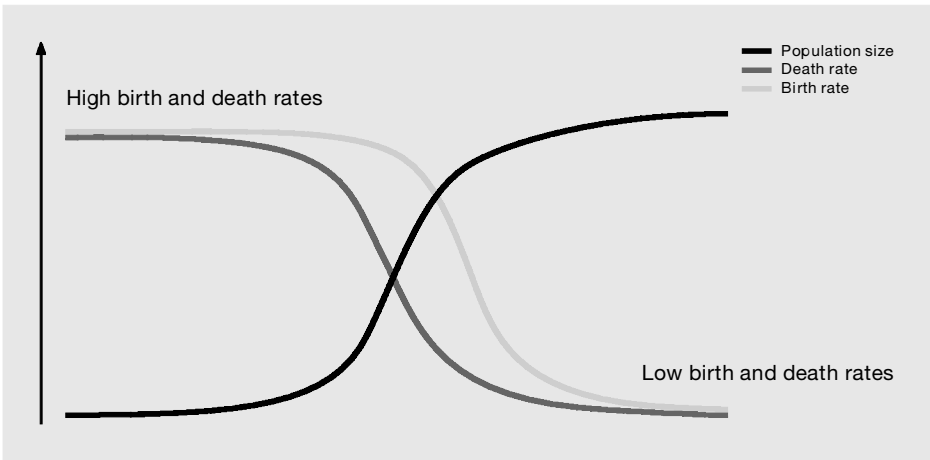
The concept of transition has its roots in biology and population dynamics.[1] In recent times the process has typically been sparked by improvements in hygiene and health care. During this phase, the death rate falls spectacularly, whilst the birth rate remains high, causing the population to increase at a fast rate. However, in most Western societies this has been followed a fall in the birth rate, leading to a phase of stabilization. The driving forces in this are usually education, the labour participation of women, economic development and family planning.

We call a demographic transition successful when birth and death rates stabilize after a period of growth. In a failed demographic transition, by contrast, the birth rate does not fall to the same extent as the death rate. As a result, the transition does not come to a new equilibrium and the size of the population keeps increasing significantly. This is the plight of many developing countries, for whom demographic transition seems forever postponed.

Figure 1 Demographic transition



The concept of transition can be used to describe various developments. It is being used to track social change in Eastern Europe and has also been used in studies of socio-technical change (where it is conceptualized as a technological regime shift).[3]

A transition can be defined as a gradual, continuous process of change where the structural character of a society (or a complex sub-system of society) transforms. Transitions are not uniform, and nor is the transition process deterministic: there are large differences in the scale of change and the period over which it occurs. Transitions involve a range of possible development paths, whose direction, scale and speed government policy can influence, but never entirely control.

Something in the air

A transition is the result of developments in different domains. In other words, a transition can be described as a set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behaviour, culture, ecology and belief systems. A transition can be seen as a spiral that reinforces itself; there is multiple causality and co-evolution caused by independent developments.

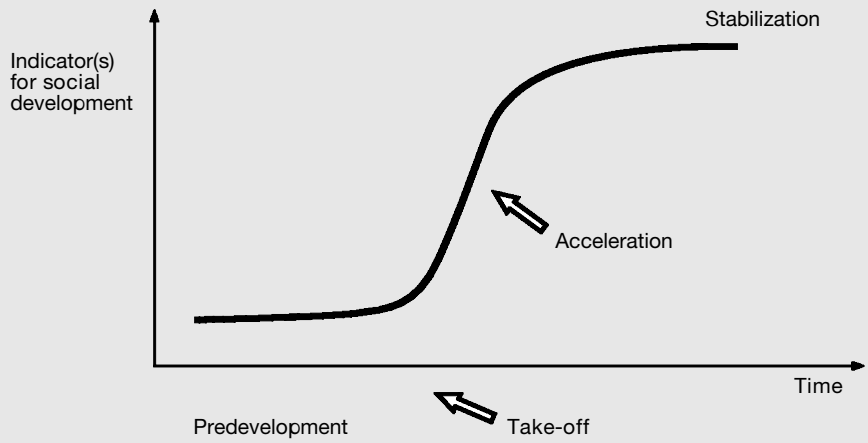
1 K. Davis, 'The world demographic transition', *Annals of the American Academy of Political and Social Science*, Vol 237, No 4, 1945, pp 1-11; F.W. Notestein, 'Population, the long view', in T.W. Schultz, ed, *Food for the World*, Harris Foundation Lectures, Chicago, 1945, pp 36-57.

Because transitions are multi-dimensional with different dynamic layers, several developments must come together in several domains for a transition to occur. To use a mechanical metaphor, all social phenomena have an *impulse value* for transitions, but only some provide a *flywheel* force.

At the conceptual level, we can distinguish four different transition phases (see Figure 2):

- A *predevelopment* phase of dynamic equilibrium where the status quo does not visibly change.
- A *take-off* phase where the process of change gets under way because the state of the system begins to shift.
- A *breakthrough* phase where visible structural changes take place through an accumulation of socio-cultural, economic, ecological and institutional changes that react to each other. During the acceleration phase, there are collective learning processes, diffusion and embedding processes.
- A *stabilization* phase where the speed of social change decreases and a new dynamic equilibrium is reached.

Figure 2 The four phases of transition



Different social processes come into play during the various phases. It is also important to realize that fundamental changes do not necessarily occur in all the domains at the same time.

It should be noted that the concepts of speed and acceleration are relative: all transitions contain periods of slow and fast development. Nor is a transition usually a quick change, but a gradual, continuous process typically spanning at least one generation (25 years). Because the established equilibrium involves stability and inertia, a transition also implies a fundamental change of assumptions and the introduction of new practices and rules. This can be accelerated by unexpected or one-off events: for example, war, large accidents (eg Chernobyl) or an oil crisis.

Integrated systems and the evolutionary approach

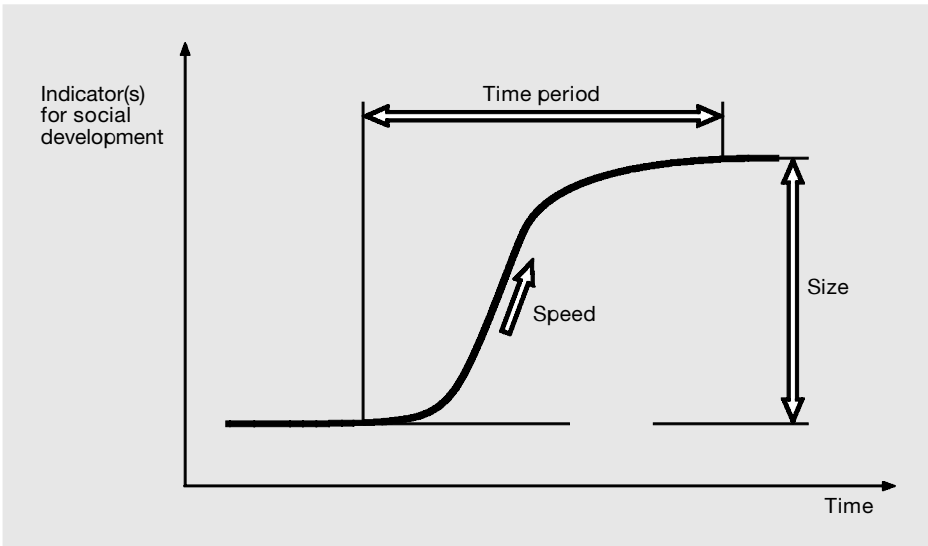
If we examine the phenomenon of transition from the point of view of a system, we see a transformation from slow dynamics to quick development and instability, reverting to relative stability. The new equilibrium is a dynamic equilibrium, ie there is no status quo, because a lot is changing under the surface. Transitions are characterized by strong,

non-linear behaviour. During the quick period of growth, the acceleration is mainly the result of positive feedback mechanisms in the system thaat reinforce each other. In general, a transition has three system dimensions:

- the speed of change;
- the size of change; and
- the time period of change (see Figure 3).

In principle, it is possible to have different paths to the same equilibrium level. It is also possible for the same transition pattern to be realized in different ways.

Figure 3 The three system dimensions of transition: speed, size and time period



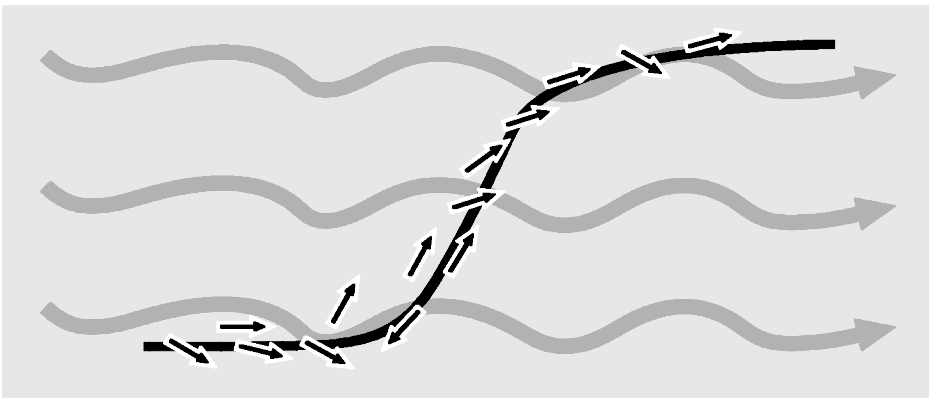
The system approach implies thinking in terms of *stocks* and *flows*. Stocks are properties of a complex system that change relatively slowly (with regard to total volume) over a long period of time. Stocks are described in terms of quantity and quality. In terms of transition management their important characteristics are: amount of influence, response time, amount of self-renewal, functions and the role of actors. Flows are aspects that change relatively quickly in the short-term and reveal the relationship between stocks.

A distinction can be made between material flows and information flows. GNP is an example of a flow indicator, because it measures all short-term economic transactions. The total amount of economic capital goods is an example of a stock indicator. In the Netherlands, approximately NLG 100 billion per year is invested in fixed assets, of which 40% is in production resources and the rest is in houses, buildings and other infrastructure. For nature and the environment, emissions to water, soil and the air can be regarded as being flow indicators.

The quality of water, soil and air, as well as the size and quality of nature expressed in biodiversity, on the other hand, are examples of stock indicators, because they refer to the long-term state of nature and the environment. Examples of socio-cultural stocks are social cohesion, the structure of the population, lifestyle, cultural identity and the political climate. Indicators for these stocks are still rare. However, there are indicators for many flows in the social-cultural domain relating to various aspects of living, working, leisure time and health.

A transition is the result of long-term developments in stocks and short-term developments in flows. Every domain has its own dynamics. Cultures only change

Figure 4 A transition is the result of long-term developments in stocks and short-term developments in flows



slowly, just like ecological systems. Economic changes, however, can take place suddenly and are usually determined by the lifespan of capital goods. Institutional and technological changes are somewhere in between. The whole picture, therefore, is a mélange of fast and slow dynamics, the tempo and direction of which are ultimately constrained by the slowest processes, ie developments in stocks.

The concept of transition can be used at different aggregation levels, such as companies, sectors, countries and regions. In this way, developments can be tracked over the course of time and compared to each other. In terms of social organization, roughly three different levels can be distinguished: micro, meso and macro. The micro level comprises individuals or individual actors (companies, environmental movements). The meso level comprises networks, communities and organizations. Finally, the macro level comprises conglomerates of institutions and organizations, eg a nation or federation of states.

This division of micro, meso and macro levels fits closely with the classifications used by Rip and Kemp to describe changes in socio-technical systems, namely the division into niches, regimes and socio-technical landscapes.[2] Although this taxonomy originates from the study of changes in function-oriented systems related to energy and food production, it also appears useful for the analysis of broad social changes.[3]

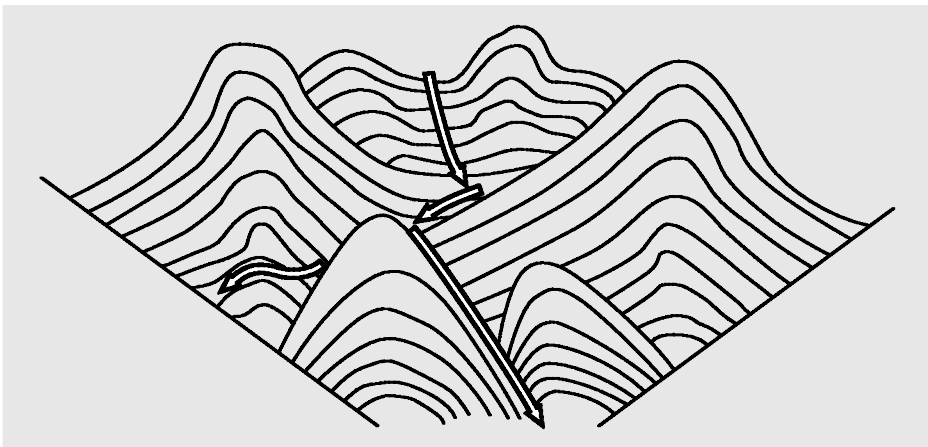
The *socio-technical landscape* relates to material and immaterial elements at the macro level: material infrastructure, political culture and coalitions, social values, worldviews and paradigms, the macro economy, demography and the natural environment. The second level, that of *regimes* (meso level), relates to dominant practices, rules and shared assumptions. At the meso level are the interests, rules and beliefs that guide private action and public policy – for the most part geared towards optimising rather than transforming systems. The *niche* level (micro level) relates to individual actors and technologies, and local practices. At this level, variations to and deviations from the status quo can occur, such as new techniques, alternative technologies and social practices.

Often in the early period of a socio-technical transition, the regime acts as an inhibiting factor. Typically it will seek to improve existing technologies and use strategic action to fight off a new development. Later on, however, once a new technology system comes into its own, the regime can have an enabling role, through the application of large amounts of capital and organizational power.

2 A. Rip and R. Kemp, 'Technological change', in S. Rayner and E.L. Malone, *Human Choice and Climate Change – An International Assessment, Vol 2*, Batelle Press, Washington DC, 1998, pp 327-399.

3 F. Geels and R. Kemp, 'Transities vanuit socio-technisch perspectief' (Transitions from a socio-technical perspective), background document for chapter 1 of the report, 'Transities en transitie-management' (Transitions and transition management) Rotmans *et al*, Maastricht, The Netherlands, http://www.icis.unimaas.nl/publ, 2000.

Figure 5 The macro landscape channels micro and meso developments[4]



A characteristic of the macro level is that it responds to relatively slow trends and developments. Its seismic undercurrents can play a role in speeding up or slowing down a transition, but its geology is for the most part unyielding. Changes in worldviews (belief systems) and macropolicies (such as agreements in WTO rounds or CFC control policy) may rain down upon the macro landscape, but its contours still dictate their convergence into rivers (see Figure 5).

However, this does not mean that individual actors (individuals, companies, local government) cannot be a catalyst to the transition process. Certain innovations in technology, behaviour, policy and institutions do break out of the micro level, if they stabilize into a dominant design around which learning processes take place. With the proliferation of the design comes a support basis - and, as a result, the momentum for take-off at the meso and macro level. Alternatively, such a take-off at the micro level can be stimulated through developments at the meso and macro level (for example, a change in ethics, institutional changes and changes to regimes).

Regimes change as a result of internal conflict or external pressure, sometimes in response to bottom-up pressures from the micro level. They may take a defensive approach (seeking to discredit other actors), a reactive approach (of system improvement) or an innovative approach by contributing actively to a transition. They may even do all three in the course of time. The interaction between the different levels is shown in Figure 6. The multilevel aspect of transitions implies that change only breaks through if developments at one level gel with developments in other domains. But there must also be interaction between developments at the micro, meso and macro level if the transition process is to be expedited.

Energy transition – the historical context

A very important transition in the Netherlands was from a reliance on coal for energy production to the present situation, where oil and natural gas are the most important sources. This change has had major consequences for the extraction of raw materials,

4 D. Sahal, "Technological guideposts aaand innovation avenues', *Research Policy*, Vol 14, 1985, pp 61-82.
5 G. Verbong, 'De Nederlandse overheid en energie-transities: een historisch perspectief' (The Dutch government and energy transitions: a historical perspective), background document for the report, 'Transitions and transition management', Rotmans et al, Eindhoven, The Netherlands, 2000, http://www:icis.unimaas.nl/publ/.

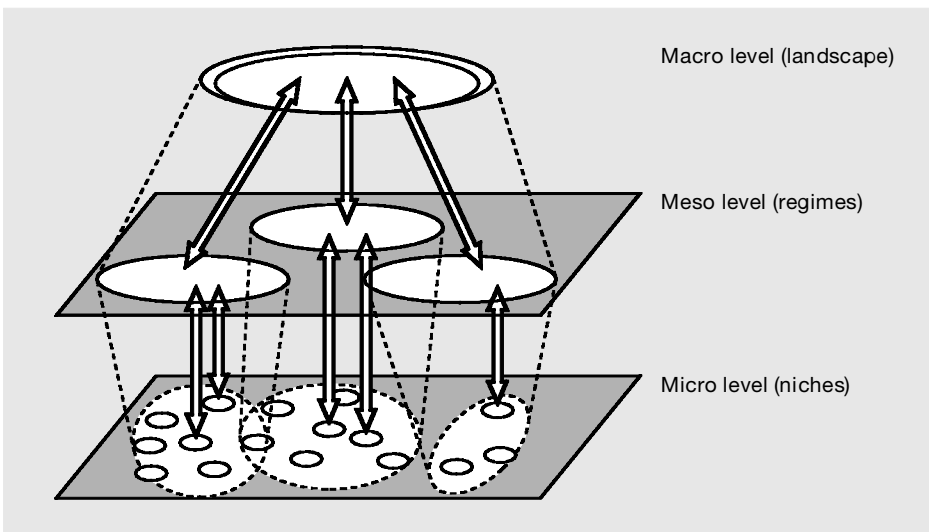
conversion technologies, and even politics and social relationships within the Netherlands. Based on a background study by Verbong,[5] we will briefly analyse the dynamic mechanisms behind this energy transition, focusing on the role of the government.

Perhaps the most striking aspect of this transition was its speed - it appeared to take place within a timeframe of just six years. In reality. however, this was only the acceleration phase of the transition. The preparation for this breakthrough, the so-called pre-development phase, was considerably longer. Useful applications for gas, initially a by-product of oil extraction, had been invented as early as the 1920s in Europe and the USA. The large-scale production and distribution of gas produced in coke factories had also been shown to be technically possible and economically attractive. The transition itself did not take place until 20 years later, after the Second World War.

At the macro level, a number of 'landscape' factors were important for the success of the transition. All around the world, gas and petroleum were being hailed as cleaner sources of energy. America was flooding the world market with cheap coal and by the early 1960s, the Netherlands coal mines were unprofitable. With the rise of nuclear power, there was also a general expectation that the price of energy was about to fall sharply. So when a large gas field was discovered in Slochteren in 1959, exploiting it became a political priority.

An important meso factor was the public-private regime of the natural gas supply. There was popular support for the idea that the government should stop the splitting-up of the gas supply. This resulted in the establishment of a state gas company, the Staatsgasbedrijf, for the distribution of gas, and a national gas company, the Nationale Gas Maatschappij, for the supply of gas, but the local councils and the semi-nationalized companies (Hoogovens and Dutch State Mines – DSM) refused to give up their power. However, after tough negotiations with the oil companies Shell and Esso, the gas supply became the monopoly of the Gasunie (Gas Association), whose shares were owned by the state and the oil companies. Under the supervision of the Gasunie, local councils retained responsibility for distribution. Hoogovens was bought out and DSM was included in the Gasunie on behalf of the government to simplify the closing of the mines. Today DSM is a chemical business.

Figure 6 Multi-level perspective



Source: Geels and Kemp.[3]

At the micro level, there was huge potential for natural gas to supply the cooking and heating needs of domestic householders. By international standards, the condition of the Netherlands' housing stock was poor. Houses were uncomfortable, lacked insulation and poorly heated, representing a (large-scale) socio-technical niche. People wanted the comforts of central heating and warm water for showers/baths. By the 1960s, the transformation was complete: the gas supply was based fully on natural gas and controlled by the Gasunie. The public was made aware of natural gas via smart advertising campaigns, which emphasized higher levels of comfort and user-friendliness.

The transformation from coal to natural gas in the Netherlands is an example of a government-inspired transition. The Dutch government had clear objectives and sub-objectives, which resulted in a very quick and relatively smooth transition. It had learned lessons from a recent national emergency in the floods of 1953, formulating the 'Delta' plan for coastal defence. Similar skills were mobilized for the transport and distribution of natural gas. Furthermore, the public was bombarded with sophisticated information campaigns about the new energy source, drawing their attention to its comfort, ease of use and cleanliness. One thing it was not was cheap: the government's tariff brought billions of guilders into the treasury.

However, we should not forget the long pre-development phase of decades, or the landscape factors. Operating largely at the international level, these could not be controlled by the Dutch government: volatile energy prices, the revolution in the international energy supply, the discovery of large quantities of natural gas, renewed economic prosperity, and popular support for the technology push of natural gas. With nuclear energy on the horizon, the regime actors believed they did not have long to make natural gas pay.

Transition management

These insights about transitions can be combined into a management strategy for public decision-makers and private actors. Transition management is based on a different, more process-orientated philosophy that balances coherence with uncertainty and complexity. It can be summarized in terms of the following characteristics:

- Long-term thinking (at least 25 years) as a framework for shaping short-term policy
- Thinking in terms of more than one domain (multi-domain) and different actors (multi-actor) at different scale levels (multi-level)
- A focus on learning and a special learning philosophy (learning-by-doing and doing-by-learning)
- Trying to bring about system innovation alongside system improvement
- Keeping a large number of options option (wide playing field).

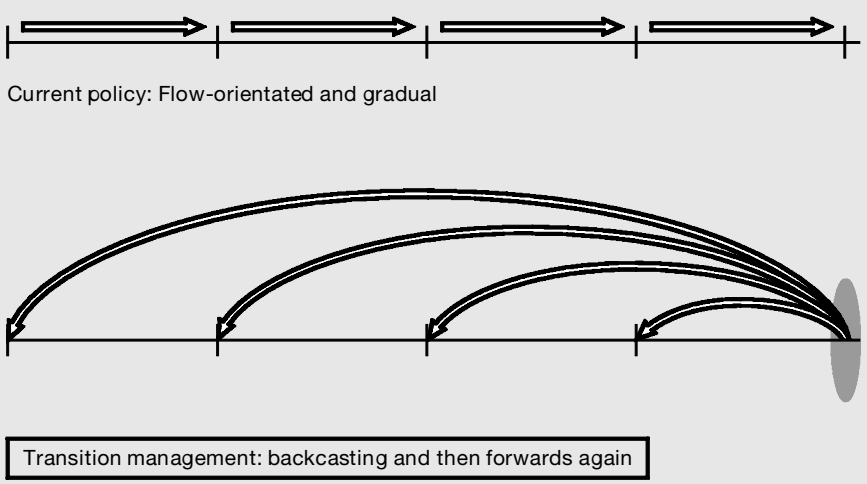
The aim of transition management is not so much the realization of a specific transition: it may be enough to improve existing systems, or the problems may turn out to be less severe than at first thought. It is about working towards a transition that offers collective benefits in an open, exploratory manner. The goals as well as the instruments of change need to be regularly re-evaluated. The transition objective is in fact a basket of objectives informed by the visions of those participating. Both objectives and final visions are determined socially, not just by expert scientific knowledge.

The various transition management steps are ultimately determined through a collective learning process of development rounds, but the basic stages are outlined below:

Transition objective

The transition objective is an important element of transition management but does not have to be set in stone. Comprising as it does a multitude of policy and actor aims, it is multi-dimensional and should not be defined in a narrowly technological sense. More

Figure 7 Short-term versus long-term policy



about sketching ambitions than setting objectives, it is subject to re-evaluation and re-adjustment. Policy in areas of health protection and the environment, for example, has traditionally been based on quantitative standards derived from studies of social risk, adjusted for political expediency. Transition management is based on a different policy approach, which aims at more flexible, semi-quantitative or qualitative objectives. Risk-based target-setting is doomed to fail in any case in areas such as climate change or sustainable development; complex, multi-scale problems where the associated risks cannot easily be expressed in fixed, purely quantitative objectives.

However, transition management is about integrated risk analysis and setting minimum levels for certain stocks (eg health, ecosystem diversity and capital goods) and aspiration levels.[6] The estimates of various types of risk are subjective, since the risks are surrounded by structural uncertainties, legitimating the incorporation of various perspectives.[7] The net result is a policy corridor for key variables, indicating the margins within which the risks are considered acceptable.[8]

Transition visions

Transition management is based on long-term visions which function as a framework for formulating short-term objectives and evaluating existing policy. If they are to adumbrate transitional pathways, these visions must be appealing and imaginative and be supported by a broad range of actors. Inspiring final visions are useful for mobilizing social actors ('putting a man on the moon', for instance, or 'underground transport'), although they should also be realistic about innovation levels within the social subsystem in question.

The 'basket' of visions can be adjusted as a result of what has been learned by the players in the various transition experiments. The participatory transition process is thus a goal-seeking process, where both the transition goals and visions change over time. This differs from so-called 'blueprint' thinking, which operates from a fixed notion of final goals and corresponding visions.

6 Rotmans *et al, op cit*, Ref. 3.
7 M.B.A. van Asselt, *Perspectives on Uncertainty and Risk: the PRIMA Approach to Decision Support*, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2000.
8 J. Rotmans and M. den Elzen, 'Halting global warming: should fossil fuels be phased out?', in M. Lal, ed, *Global Warming: Concern for Tomorrow*, Tata McGraw-Hill Publishing Company, New Delhi, 1993.

Interim objectives

Figure 7 shows the similarities and differences between current policy-making and transition management. In each case, interim objectives are used. However, in transition management these are derived from the long-term objectives (so-called 'backcasting'), and contain qualitative as well as semi-quantitative measures. In other words, the interim transition objectives contain content objectives (which at the start can look like the current policy objectives, but later will increasing appear to be different), process objectives (quality of the transition process, perspectives and behaviour of the actors concerned, unexpected developments) and learning objectives (what has been learned from the experiments carried out, have more options been kept open, re-adjusting options and learning objectives).

Evaluating and learning

Transition management involves the use of so-called 'development rounds', where what has been achieved in terms of content, process dynamics and knowledge is evaluated.[9] The actors who take part in the transition process evaluate in each interim round the set interim transition objectives, the transition process itself and the transition experiments.

Firstly, the set interim objectives are evaluated to see whether they have been achieved; if this is not the case, they are analysed to see why not. Have there been any unexpected social developments or external factors which were not taken into account? Have the actors involved not complied with the agreements that were made?

The second aspect of the evaluation concerns the transition process itself. The set-up and implementation of the transition process is put under the microscope. How do the actors concerned experience the participation process? Is it dominated by certain parties (vested interests)? Is it too consensual (cosy), or is there too little commitment? Are there other actors who should be involved in the transition process? Are there other forms of participation which must be tried out?

The final issue for evaluation is the amount of learning or 'enrichment' that has taken place in the previous period. A special point of attention is what has been learned from the experiments carried out to stimulate the transition. What have been the most important learning moments and experiences? Have these led to new knowledge and new circumstances? This last aspect, in particular, is important in development rounds: 'What have we learned and obtained, and how do we continue from there?'.

Creating public support

In transition management, participatory decision-making helps to create support for policies. But this can also be created in a bottom-up manner, through local support for new technologies. Education too can allay many fears regarding the prudent introduction of new technology in suitable applications. Using both top-down and bottom-up techniques takes advantage of the heterogeneity of society, by exploiting niches and allowing collective learning to take place.

Transition management in relation to current policy

Transition management should be seen as complementing rather than conflicting with current policy, bringing added value by placing it in a more long-term perspective. It is a proactive, anticipatory strategy that is particularly sensitive to grassroots innovation. The concept of transition also places short-term policy within a time frame of one, two

9 E.F. ten Heuvelhof and M.J.W. van Twist, *Nieuwe Markten en de Rol van de Overheid* (New markets and the role of the government), ESB dossier, Liberalization of network sectors, 2000; G. Teisman, Sturen als ontwikkelingsopdracht (Guidance as a development assignment), in *Report of Discussions with Scientists During the NMP4 Process*, RMNO, The Hague, The Netherlands, 2000, pp 64-67.

or three generations (50-100 years) rather than the maximum of 5-10 years which is typical of current policy. Unfortunately, the fruits of current policy are more visible in the short term: in the area of emissions, for example, through the use of fluegas desulphurization units at coal-burning power stations, or CO_2 collection and storage. However, achieving quick results with existing technology won't do in the long term in dealing with complex social problems.

This does not mean that transition management rejects the improvement of existing systems as a route towards sustainability. It says that you must aim for both system optimization and system innovation. They are not mutually exclusive: cleaner cars can go hand-in-hand with innovative public transport systems. System improvements may thus act as a stepping stone for system innovation. Another example is organized car sharing, which facilitates intermodal travel.

A characteristic of transition management is that it achieves structural change gradually, without too much destructive friction in the form of social resistance. The rationale behind the gradual approach is that a transition can be brought about by the gradual transformation of an existing system, instead of the planned creation of a new system. New elements can be added, for example, in order to solve a specific problem. As a result of the changes, new bottlenecks will appear which, in the course of time, stimulate the development of new concepts, ideas, insight, methods and techniques.

In this way, transition management tries to utilize the opportunities for transformation that are present in an existing system. It joins in with ongoing dynamics rather than forcing changes. Transition management also implies refraining from large-scale investment in improvement options which only fit into the existing system and which, as a result, stimulate a 'lock-in' situation. It tries to utilize two-world options: options that are viable both in the existing system and in a system that satisfies the transition objectives.

Actor analysis: the role of government

Social actors can stimulate, slow down or even block a transition, so it is worthwhile to map their various action perspectives. How active should the Government be in managing a transition? Government interacts with other actors, but has its own responsibilities and resources. A vision of the future is crucial in realizing a transition: an important task for government is to assist in formulating that vision, and to inspire and mobilize other actors.

So government can and should assume a leading role in transition management. Not by acting as the great commander, enforcing change, but by inspiring a collective learning process and encouraging other actors to think along and participate. Local and regional government also have roles to play in transition management. They are closer to the citizens than national government, and have their own tasks in areas which are often relevant to social transformations, such as environmental planning, house-building and waste. Local conditions can permit radical experiments (such as car-free town centres or city heating) for which there is no wider political mandate.

Liberalization and privatization are economic priorities for any nation that wants to compete in the new global marketplace. But governments also have a guiding role, particularly when an enterprise has been removed from state control, to introduce rules and laws to guarantee that a real market is created, and not a monopoly or oligopoly. Governments can also take a number of initiatives and generate stimuli to make the market more attractive to newcomers. They have a task in creating the right boundary conditions for market processes through tax policies. This is well accepted. But aside from this, governments can also be more directly involved in processes of change, by stimulating experiments (niche management), developing new partnerships and encouraging discussion of where society should be heading.

The role of government is different in each phase of the transition process. In the

preparation phase it must play the catalyst and director, with the emphasis on maintaining a wide playing field and organizing and stimulating discussions with other actors. In the take-off phase, other actors must actually be mobilized in the direction of the transition objective. Here and in the acceleration phase, the government has to stimulate learning processes about possible solutions. This can be achieved by drawing up an agenda, forming communal visions concerning what is desirable and possible, creating niches and anticipating the actor's interests: hence a role as stimulator. In the stabilization phase, the guidance is mainly orientated towards embedding, to prevent or contain backlashes and other negative effects: so a role as controller and consolidator.

The role of government in transition management is thus a plural one: facilitator-stimulator-controller-director, depending on the stage of the transition. The most effective (but least visible) is the guidance in the pre-development phase, and to a lesser extent, in the take-off phase. In the pre-development phase, it is important to promote variation. In the take-off phase, it is important to use the momentum well. Much more difficult is the guidance in the acceleration phase, because the direction of development in this phase is mainly determined by reactions which reinforce (or weaken) each other and cause autonomous dynamics, so that processes become more rapid. It is still possible at this stage to adjust the direction of development, but it is almost impossible to reverse it.

Limitations to the role of the government

Although an important role is granted to government in transition management, there are clear boundaries and limits to what it can and should do. Firstly, there are a number of external factors (landscape factors), such as the development of energy prices and cultural values, over which the government has only limited influence. Furthermore, there are numerous constraints imposed by existing structures and arrangements, such as the political structure in Europe and the liberalized EU market. Finally, there are socio-cultural factors which influence the government's freedom to act. Social developments are increasingly the result of multi-actor processes and governments cannot easily push through developments in a unilateral and top-down manner. Creating and maintaining support for transition objectives is a perennial task.

The role of the government in transition management is in fact twofold: to realize certain content objectives such as CO_2 reductions (the content role) and to make sure that the process of variation-selection is working well (the process role). The process role is aimed at stimulating and organizing the transition process, mobilizing the social actors concerned, creating opportunities and challenges for transition participants, and creating boundary conditions within which the transition process can operate.

Case study: the transition to a low-emission energy infrastructure

The development of a low-emission energy supply in the Netherlands makes a good case for transition management. The infrastructure for the production, transport and distribution of energy represents an important social sub-system, implying institutional and socio-cultural changes as well as changes in lifestyle. As with any transition, a number of important boundary conditions are set by other domains, which can either slow down or strengthen the transition. The economic domain demands affordability and economic return; the socio-cultural domain values health, safety and reliability of delivery; while from the ecological point of view, the risks for nature and the environment are important.

From a transitional perspective, the energy issue is still in its pre-development phase. Global and European developments will have a major influence on the Netherlands' future energy supply. Yet the unsustainability of Dutch energy makes it worthy of international comparison. For the country is not only energy-intensive, it is also too

dependent on energy from fossil fuels. The principal danger here is that a technological monoculture may develop. However, as was demonstrated by last year's unrest over high diesel prices, there is also the danger of political instability. Furthermore, deferment of the transition to new energy sources only shifts the problems to later generations, because future options for the energy supply are, to a large extent, determined by current investment in R&D. The SER, an influential advisory board in the Netherlands, has stated that the energy infrastructure must change fundamentally in the long-term.

The perceived unsustainability of the existing energy system and the Dutch commitment to the Kyoto protocol are drivers for change, but there are a series of obstacles to an actual transition. An important hindrance is the overproduction of fossil fuels, leading to low energy prices. The oil companies are also a key sector of the Dutch economy. Although they claim to be investing in alternative sources of energy, in fact they fear a lock-in, and are scared of placing all their eggs in one basket (ie choosing the 'wrong' energy technology). As a result, the companies and institutions causing the CO_2 emissions have no real incentive for change. Recent studies also show that the Netherlands would be able to satisfy a tightening of the Kyoto climate objectives.[10] Finally, there is no groundswell of popular support for a change in sources of energy. In these circumstances, how can a low-emission energy system be developed through transition management?

Energy transition management

To follow the steps outlined earlier, transition management begins with the agreement of a collective transition objective. This needs to be multi-dimensional, and not only quantitative. From the socio-cultural viewpoint, safety and reliability of delivery are important requirements. The ecological risks might be specified in CO_2 concentrations. A low-emission energy supply is often translated in terms of CO_2 reductions, of the order of 50% of 1990 levels, to be realized over a period of 50 to 100 years.

The second step concerns final visions of energy transition. A recent study by the Dutch Energy Centre, ECN, articulated three visions for the future of the Dutch energy supply:[11]

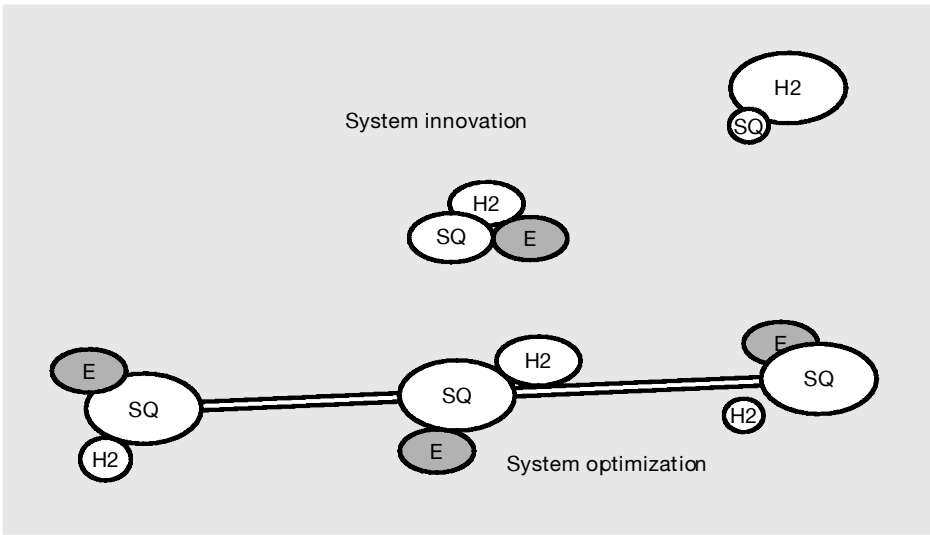
- The first vision is based on the status quo, where the current energy infrastructure remains intact, but final energy fuels are made from renewable energy resources (solar, wind and biomass). In this vision mainly the supply side of the energy supply changes. Methane, oil and electricity remain the final energy fuels. There will be more conversion steps, particularly for biomass and coal, where the primary energy fuels are both renewable and 'clean' fossil fuels (use of fossil fuels, with storage of CO_2 in empty natural gas fields or coastal seas).
- The second vision is that of a hydrogen economy. In this vision, hydrogen is the dominant final energy fuel, particularly for industry, transport and built-up areas. This requires a thorough adaptation of the current natural gas network, so that, for example, cars are able to run on hydrogen.
- The third vision is that of an all-electric society. Here, the role of electricity as the final energy fuel is dominant in all sectors of society. This requires a fundamental transformation of the current energy infrastructure, including a large-scale electricity network in order to allow cars to run on electricity, for example.

These three final energy visions are not mutually exclusive, and each combines centralized with local systems of power generation. They are, however, purely technological in their perspective: *real* transition final visions must have a social dimension. The social, cultural, institutional and environmental contexts of a transition must be considered carefully if the process is to attract the support of actors involved.

10 ECN, RIVM, 1999.

11 'Energietechnologie in het spanningsveld tussen klimaatbeleid en liberalisering' (Energy technology in the field of tension between climate policy and liberalization), Energie Centrum Nederland (Dutch Energy Centre), ECN-C-00-020, May 2000.

Figure 8 Keeping the transition options open



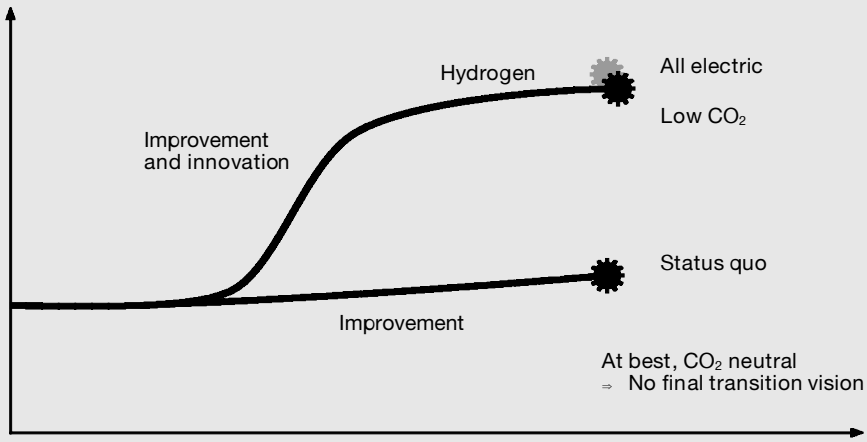
The ECN analysis suggests that all three final energy visions may lead to the desired 50% reduction in CO_2 emissions, but only if they are followed scrupulously. The roles of renewable energy sources (solar, wind and biomass) and clean fossil fuel energy in each final vision are clear; what is not so obvious is how much all the visions continue to rely on nuclear power and the parallel development of energy-saving technology. To produce the biomass alone for the first vision would require the entire Netherlands to be turned over to purpose-grown crops.

It is difficult to make judgements about the viability of the various options, as costs were not estimated. At first sight, the status quo final vision offers a lot of advantages, since the existing infrastructure can be preserved, although an exorbitant quantity of biomass is required. The hydrogen society final vision has the advantage that it can be entirely CO_2-free. Furthermore, there is considerable enthusiasm for such advanced technology. On the other hand, such a fundamental changeover would require a great deal of time and effort. The electrical society final vision opens up the prospect of a gradual transfer to low CO_2 emissions, or possibly even a CO_2-free energy supply in the long-term. There is, however, not a great deal of enthusiasm for this, partly as a result of the risks (breakdowns, disasters) and the way in which it could sideline a number of innovative technologies presently in development.

Formulating interim objectives is the third step of transition management. This allows us to describe the various transition paths behind the final energy visions. A transition management strategy can be outlined by linking the chosen final energy visions to the various transition paths. If we look at the characteristics of an energy path, a couple of things catch the eye. Firstly, there is no one-to-one relationship between the transition path and the final transition vision. Secondly, the energy transition is not a series of jumps, but a process of gradual development.

Given the uncertainty about which option is best, all the formulated final visions (status quo, hydrogen, electricity... maybe one or two more) must be kept open. It may take decades for a technology leader to emerge (see Figure 8). The other options then gradually disappear from the picture, although a hybrid always remains possible. Though the rise and fall of options is evolutionary and largely autonomous, it is not outside the control of government. Even within a continuously changing economic, technological, environmental and institutional context, a strategic policy towards system innovation can refocus or redirect the transition.

Figure 9 The Kyoto process and the process of systems innovation



The Netherlands' current policy is orientated towards observing agreements such as the Kyoto Protocol in 2010. But neither the Kyoto policy nor the proposed, tighter Kyoto+ policy are examples of energy transition management. They focus on the reduction of non-CO_2 greenhouse gases, and CO_2 reductions abroad (maximal 50% of the proposed reduction) in the period 2000-2020. This way, national CO_2 emissions in 2010 could still be 9% higher than in 1998.

The Netherlands could achieve CO_2 reductions of approximately 13% in the period 2010-2020, according to the ECN report (making final CO_2 emissions in 2020 approximately 6% lower than in 1998), but only by a Herculean effort. Unless accompanied by structural change in the energy infrastructure, it would require massive use of renewable energy and enormous investment in energy-saving. Yet this seems to be the way the country is headed. With the focus on the medium term (reaching no further than 2020), there is little sign of change to the current energy infrastructure, based on oil, gas and electricity.

Not only does this reduce the time available to change from 50 to 30 years, it effectively locks out two of the three transition visions: the hydrogen and electricity societies (see Figure 9). Nothing is turned upside down, there is no forced change to the energy infrastructure. Promising alternative energy options are locked out. A transition may still be possible but one does not really prepare for it.

Getting back on track

If this situation is ever to change, research programmes must be aligned with transition agendas, and innovation and experimentation at local and regional level (in new energy technologies, new instruments and new arrangements). We know too little about the social and institutional aspects of transitions, and the extent to which institutions change and are changed by them. The process side of transition management lacks a satisfactory knowledge base. It is, therefore, of crucial importance that we carry out in-depth research into the dynamic behaviour of the actors involved in a transition: their motivations, preferences and paradigms. To what extent do they influence each other, and how may they may enlisted in the transition effort?

Research must first be carried out into so-called systems of interaction. Attention must be paid to the social and material context of interaction, and processes of co-evolution.

For energy transition management, research into the non-technical barriers to a low-emission energy transition is important. But apart from research there should also be investment in new options, for example in decentralized energy systems like the use of photovoltaic (PV) energy. Not as a solution, but as a learning experiment – to maintain a wide playing field (or alternatively, a hedge against changing circumstances). Interesting learning experiments might include the large-scale positioning of wind turbines in the North Sea, and the use of biomass in conventional power stations. This will tell us how much space would be needed for the cultivation of biomass. What would it mean for biodiversity? How would it affect the balance of power in the world?

Another important question for transition management is how to keep open the pathways to new energy supplies. Can the current natural gas network be made suitable for hydrogen? Could CO_2 storage play an interim role in a large-scale transformation process? Can we stimulate demand-led innovation through the use of vehicles and equipment powered by alternative fuels?

Development rounds allow goals and instruments to be evaluated. Possible criteria for evaluating short-term actions and experiments from the point of view of transition include:

- Do the actions and experiments taken provide insight into the coherence between nature and the environment, and between the socio-cultural, economic and institutional dimensions of a transition?
- Are the possibilities for innovation and transition paths explored through the action and experiments taken?
- Do the actions and experiments taken contain the potential for learning?
- Do the other actors adopt the transition objective as their own action perspective?

The final transition management step consists of creating social support. This is a recurring theme throughout the transition process. In the context of energy it requires a background of support in society for climate change policy and transparency about the motives of actors, but also modest investments in alternative energy sources. In a liberalized and privatized energy market this can be a problem: energy companies tend to focus on the short term, aiming at maximum return on investments in the current energy infrastructure.

The Dutch government is still searching for its role in the dynamic energy market. Events are moving faster at the supra-national (EU) and local levels, where experiments with renewable energy are widespread. The government presently maintains high quality, safety and relatively cheap distribution for energy, but users will be empowered when they get a free choice of energy supplier in 2002. They will be able to stimulate new developments (for example, solar boilers, PV), but also to slow down new developments or even stop them (for example, heat pumps). Transition policies should be sensitive to this.

Conclusions

In this paper we have explored the notion of transition and applied it to the future energy supply in the Netherlands. A major conclusion of our study is that no single actor can steer the transition to an innovative, low-emission energy supply.[12] All social actors look to the government to take the lead. The government has taken action but does so in a rather myopic and episodic way. In the field of renewable energy, it has an extensive set of instruments, ranging from subsidies for clean energy technologies and long-range agreements about energy-saving, to green certificates for renewable energy. However,

12 The same is true for car-based transport, which is highly unsustainable in terms of emissions, noise, safety and spatial needs.

the government's policy has hardly been developed in other energy fields, such as the transport sector, the chemical industry and the heat supply. Transition management could help to better coordinate public policy and legitimize policies. It could also mobilize problem-solving capacities in society.

Yet in spite of its limitations, the national government has a key role to play in advancing a low-emissions energy transition. Its guiding role is concerned with both process and content (outcome). An energy transition policy contains the current climate policy, but adds something to it: a long-term vision, an impulse for system innovation, and greater coherence between short-term and long-term policy, and between micro and macro developments.

The guidance for the process of a transition will require a different form of participation, however, with new actors. Via a process of so-called niche participation, new players who are as yet insignificant but who may become important in the future can also become involved in the process. These actors may be brokers for renewable energy, communities for sustainable energy lifestyles, or producers of new energy technologies. In organizing the transition process, the government can form an interdepartmental body or create an external entity of private and public decision-makers responsible for transition management.

Although we have examined transition management in relation to energy policy in the Netherlands, we have also seen how it can be used as a new approach to complex policy problems. By identifying levers for private and public action, transition management can legitimize policy interventions for long-term change. To underpin the concept of transition management, however, more research is needed on transitions and the role of goal-oriented agency. With this paper we hope to invite researchers from different disciplines to engage in this challenging endeavour.

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