

Title

Systemic transitions, systemic policies: mapping and managing policy options in complex innovation environments

Authors

Toni Ahlqvist; VTT Technical Research Centre of Finland; P.O.Box 106; 20521 Turku, Finland;
E-mail: toni.ahlqvist@vtt.fi

Mika Nieminen; VTT Technical Research Centre of Finland; P.O.Box 1300; 33101 Tampere, Finland;
E-mail: mika.nieminen@vtt.fi

Heidi Auvinen; VTT Technical Research Centre of Finland; P.O.Box 1000; 02044 VTT;
E-mail: heidi.auvinen@vtt.fi

Anu Tuominen; VTT Technical Research Centre of Finland; P.O.Box 1000; 02044 VTT;
E-mail: anu.tuominen@vtt.fi

Juha Oksanen; VTT Technical Research Centre of Finland; P.O.Box 1000; 02044 VTT;
E-mail: juha.oksanen@vtt.fi

Keywords

Systemic transition, systemic policy, socio-technical change, innovation environment, integration of methods, transport system.

The motivation

It has become evident during the last few decades that we need policies that are “systemic” by nature. As previously policy-making was more or less limited to sector-specific “silos”, it has been increasingly realized that the decisions made at one policy sector affect other sectors and form also complex feedback loops among policy sectors. The need of systemic policies has become evident hand in hand with observations emphasizing that increasing complexity and dependencies of modern society have made it hard to predict consequences of policy actions (cf. Taleb 2012). Need for systemic policy is also increasing because various societal subsystems are highly connected to each other. For instance, it has been estimated that altogether some 47 percent of each societal subsystem’s outputs is contributed by inputs from other subsystems. Such subsystems are e.g. healthcare, education, transportation, food, finance etc. (IBM 2010) Similarly, innovation policy cannot be limited to a specific “silo” or to sector specific issues, as innovation policy interlinks cross-sectorally various fields of policy-making e.g. from trade and industry to education policy and health care (cf. OECD 2010, OECD 2005). The need of systemic policy stems also from the fact that innovations are inherently systemic by nature, and require systemic policy framework for their support (Wieczore & Hekkert 2012).

There is currently an apparent need to develop systemic innovation policy approaches, that is, more holistic ways to comprehend and steer the development of complex socio-technical systems. In practice this necessitates new kinds of methods, which are at the same time valid, adaptive and future-oriented.

The approach

We have utilized a new kind of combination of foresight, assessment, system dynamic modelling and societal embedding (see Ahlqvist et al. 2012) in order to understand a highly complex and evolving socio-technical system (e.g. Geels 2002). The framework is based on an idea that innovation-related strategic decision-making situations vary by their contextual and technological orientation. The core idea is that varying combinations of societal and technological dynamics form distinctive contexts.

In this paper we present conceptual tools as well as a methodological model on how to manage policy options. Our paper has three sections. The first section describes our perspective to policy in the systemic context. We discuss the notions of systemic policies and policies of the systems as a meta-level heuristics. In our view, the policy processes in systemic settings are increasingly processes of policy design. In our usage, policy design refers to an adaptive and experimental approach in which a selected

variety of policy instruments are applied either simultaneously or successively. What these instruments are and how their sequential flow is organized depends on the characteristics of the system under policy intervention. These system characteristics are, for example: actor assemblages, enabling technologies and related infrastructures, a temporal scope of the system (e.g. what is short-term, what is long-term) and spatial scales of the system (e.g. local, regional and national). In policy design, multiple policy instruments are adapted and tested in parallel. Thus policy design aims to increase the resilience of the policy practices in the systemic contexts by allowing space for policy experimentation.

The second section discusses different methodological approaches to analyse the systemic policies. Our approach bases on the methodological combination of foresight, system dynamic modelling and future-oriented assessment. The first step is to form as concrete as possible an *overall system vision* ("roof vision") that explicates the boundary conditions for the systemic transitions. The second step is to build a system dynamic model that can be used to test alternative and complementary *vision paths* of the system to be elaborated. These transition paths could be based on some social or technological innovation, or most likely a combination of both. The third step is to build quite detailed maps of the necessary components in the transition paths. We have developed a framework we call a *system transition roadmap* to enable this step. System transition roadmap adapts the key levels of the multi-perspective model (see e.g. Geels 2002; 2004; 2007) with the extrapolation of the systemic development phases defined by the authors.

The key levels, when adapted to the context of transport system, are: technologies and services (niche level), transport system (regime level), and landscape drivers. The systemic development phases in the context of the transport system are the following: 1) Emergence: initial statements that set the agenda for the systemic transition; regime is at the start of transition due to internal regime dynamics and due to the pressures both from the landscape and the niche levels; initial structures of a new systems are beginning to take shape; 2) Diffusion: the system transition agenda is deepening and diversifying; a range of key actors push the system transformation in multiple fronts; the awareness of the transformations is spreading throughout the society; the common rules of the new system are forming; legislation and institutionalisation starts; new enabling technologies are emerging that are particularly connected to the needs of the novel system; 3) Consolidation: the novel system is at the phase of institutionalisation and stabilisation; the system is structured in the consciousness of the surrounding society; the system has a legitimised role and activities in the society; there are legitimate core actors that are the official representatives of the system; formation of a transitory systems will start at the edges of the consolidated system. The fourth step is to assess and model the policy instruments for the vision paths. The policy instruments should be identified in three

levels: more traditional supply and demand side measures, but also more novel systemic policy instruments (see e.g. Hekkert et al 2011).

The third section depicts our case study, which is an analysis of transport system transition in the Helsinki metropolitan region.

Expected results

We demonstrate a system dynamic model of the transport system in the Helsinki metropolitan region. The overall vision for the system was to enable emission free transport in cities 2050. In the case analysis, and in the modelling exercise as the main part of it, we explore the principle vision in the context of the Helsinki metropolitan area. Three alternative vision paths emphasising three different solutions to reach the vision were then mapped. The first one focuses on replacing the conventionally-fuelled cars in urban transport by electric vehicles. The second one emphasises replacing conventional transport fuels with low carbon biofuels. The third one highlights the modal shift from private cars to public transport, walking and cycling. In this paper we, however, focus on the aspects of systemic policies and systemic policy instruments. We do not touch so much upon the modelling of the system, but instead we focus on some key principles on how to systemically draw policy conclusions from the complex system dynamic models.

Conclusions and policy implications

The paper introduces new methodological tools for understanding and steering evolving socio-technical system. The specific advantage of the suggested approach is that it is able to concretely assess the consequences of various policy actions (including the more systematic possibility to map the intended and unintended consequences of the policies), define various paths to desired societal vision, and assess the usability of various policy measures in the context of specific socio-technical change. The diffusion and development of new innovations depends on the social context and selected policy measures. The case of emission free transport indicates concretely, how an optimal mix of various policy measures may support change towards desired vision in a complex socio-technical environment, and how various possible paths towards vision can be defined.

Literature

Ahlqvist T., Nieminen M. Tuominen, A., Auvinen H. (2012) Towards strategic management of complex systemic innovation environments: Integrating foresight, assessment, system dynamic modelling and societal embedding into a coherent model.

In: *Towards Transformative Governance? Responses to mission-oriented innovation policy paradigms*. Book of Abstracts. 2012 EU-Spri Conference. Fraunhofer Institute for Systems and Innovation Research ISI.

IBM (2010) The world's 4 trillion dollar challenge. Using a system-of-systems approach to build a smarter planet. IBM Institute for Business Value. IBM.

Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, 31, 1257–1274.

Geels F.W. (2004). From sectoral systems of innovation to socio-technical systems. Insights about dynamics and change from sociology and institutional theory. *Research Policy*, 33, 897–920.

OECD (2010). *The OECD Innovation Strategy. Getting a Head Start on Tomorrow*. OECD.

OECD (2005). *Governance of Innovation Systems: Synthesis Report, Vol. 1*, Paris, France: OECD Press.

Rotmans J. & Loorbach D. (2009). Complexity and transition management. *Journal of Industrial Ecology*, 13, 2, 184–196.

Taleb. N.N. (2012) *Antifragile: Things That Gain from Disorder*. Random House: New York.

Wieczorek A.J. and Hekkert M.P. (2012) Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy* 39 (2012) pp. 74–87.