OECD Science, Technology and Innovation Outlook 2016

Policy Profile

System innovation

Rationale and objectives

Interest in system innovation is motivated by the realisation that system-wide changes are necessary to make economies socially, economically and environmentally sustainable. Although many national governments have put sustainability and green growth objectives at the centre of their economic development strategies, achieving this goal will require wide-ranging changes in their underlying economic, technological and social systems, from transport, water and energy systems to modes of consumption and waste management. Ensuring that socio-technical systems move towards greater sustainability is a major challenge for governments but also for civil society. At the core of the transition is a shift in governance structures that not only allows change to occur but also directs and orchestrates some of the changes. The "smart city" and "circular economy" initiatives that mobilise technological and social innovations to make the production and consumption of a city's goods and services more sustainable illustrate this point.

A key leitmotiv is that socio-technical systems, whether local, national or sectoral, are not responding swiftly enough to global challenges in areas such as climate, energy, food, transport and health to avoid bleak scenarios. Whereas the economic rationale for innovation policy traditionally lies in the market and system failures that are familiar to STI policy makers, including the need to internalise externalities that dampen the incentive to invest in innovation and to foster co-ordination within the system to improve synergies, the rationales for a system innovation go well beyond these; other failures such as demand articulation failures (i.e. hidden or weak demand) are considered reasons for public action. Furthermore, while traditional innovation policies have placed an emphasis on the Schumpeterian force of creative destruction, system innovation theories argue that destruction or at least disassembly of existing infrastructures, regulations, norms or standards, may be needed for new solutions to emerge and scale. A case in point is the hard and soft infrastructure for a fossil based economy which enables incumbents to resist challengers and change.

Major aspects and instruments

The concept of system innovation can be characterised as a horizontal approach to innovation policy directed at problems that are systemic in nature such as transitioning towards low carbon energy systems or low carbon transport systems. It is one that involves engaging a range of private and public sector actors and takes a longer-term view in policy:

Some of the defining characteristics of system innovation are:

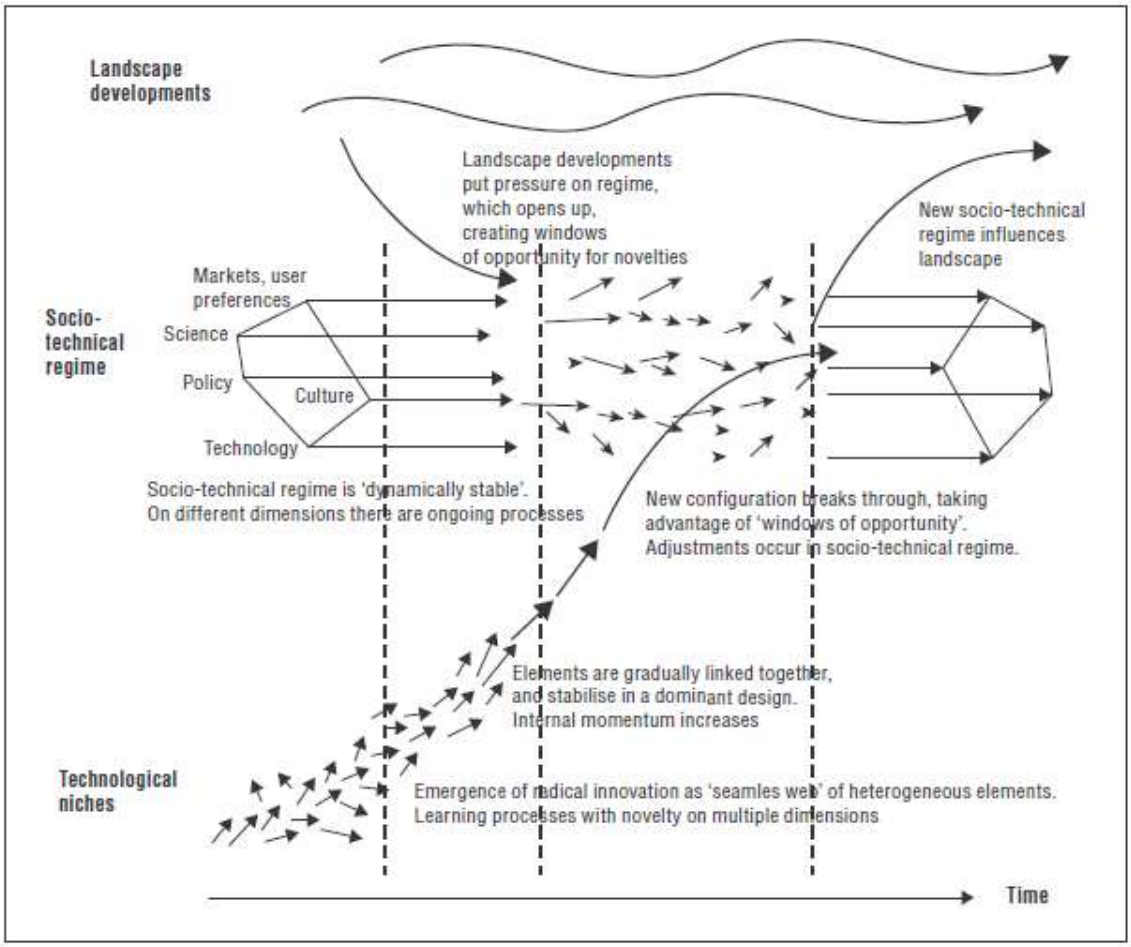
- Large-scale transformations in the systems that fulfil societal functions such as housing, mobility, or food (Elzen, 2004).
- The transformations happen through a process of co-evolution between the different elements and actors in socio-technical systems.
- These transitions or transformations occur at multiple levels referred to as the niche level (i.e. an 'area' where there is space for radical innovation, experimentation and learning); the regime level where dominant and stable systems operate; and the landscape or wider political and economic level.

- The development of a fundamentally different knowledge base and technical capabilities that either disrupt or *complement* existing competencies and technologies, resulting in new combinations. For example, synthetic biology has a strong potential to revolutionise industrial and biological processes. However, innovation based on the technology is limited by a range of systemic factors such as regulatory barriers or a lack of coherence between research funding policies and product and safety regulations and technical and market risks (e.g. scale, financing).

- Changes in consumer practices and markets. New technologies and business models are often diffused by lead users or early adopters.

- Changes in infrastructure and other elements, including policy and culture. An example is modern mobility systems (i.e. e-mobility) that are evolving as a result of underlying changes in technology, ownership structure, consumer preferences and related changes in energy systems and their linkages to other systems.

Figure 1. A dynamic multi-level perspective on system innovations



Source: OECD (2013), adapted from Geels (2002), p.1263.

Figure 1 presents a stylised pattern of transitions in socio-technological systems based on the multi-level perspective (MLP). The most important novel insight of the MLP is that a transition from socio-technical system to another results from the interaction of events on all three levels (Geels, 2002; Schot and Langer, 2016). Technological innovations arise first in niches then gather momentum and a dominant design emerges; the emergent dominant design interacts with the prevalent socio-technical regime and eventually breaks through. Pressures exerted by developments in the landscape (i.e. the general socioeconomic context) may present opportunities to upset the status quo sooner; the absence of such pressures may thwart the

transition. Breakthroughs are not guaranteed and, in practice, there are a variety of possible outcomes, as the impulses interact with existing technologies and actors in the system (e.g. fuel-cell-powered vehicle technology versus hybrid vehicles).

One of the key arguments in the system innovation literature is that not only are existing technologies and infrastructure a source of lock-in and resistance but the institutionalisation of policy can also be a source of lock-in that constrains the effectiveness of new initiatives. Therefore policy learning is a key dimension of the systems innovation approach to policy. Initiatives are designed and deployed in way to promote learning in the design and monitoring and evaluation of the programmes in order to identify barriers, misalignments and gaps in policy as well as to leverage commitment from different stakeholders.

Recent policy trends

Implementation of system innovation as framework for policy making is a recent development spurred by forward looking governments, innovation agencies and regions in countries such as Belgium, the Netherlands, Finland, Sweden and the United Kingdom but also Korea and Japan which are experimenting with a systems approach and use the systemic policy instruments such as longer-term (5-10 years) innovation funding programmes; roadmapping; new cluster policy; smart regulation and demonstrators. Many other OECD countries are also mainstreaming system-based approaches to innovation policy in the context of dedicated green economy agenda or as part of energy and industrial regeneration strategies. Recent policy initiatives, some of which are also the focus of case studies for the OECD's Working Party on Innovation and Technology Policy include the following:

- *Austria.* National Platforms for Industry 4.0 are an example of a mainly policy driven national initiative that has been set up in a top-down mode. The platform explicitly addresses the complex challenges of the transition of SMEs towards Industry 4.0. Although, initiated top-down, platforms encourage the participation of all stakeholders. Meanwhile the Austrian Energy Strategy continues to promote the development of a support system for electro-mobility centred on support for technology, education, and internationalisation. International technology standards and the need to take account of consumer preferences are some of the key hurdles in promoting the diffusion of electro-mobility technologies and innovations.

- *Belgium:* Belgium (Flanders) has been a pioneer in using system innovation as a policy approach. Transition management tools were first adopted in 2004 to tackle the systemic challenge of sustainable living and housing by starting a transition arena called DuWoBo. The Industrial biotechnology Roadmap for Flanders, based upon an extensive study of the European and worldwide landscape of the industrial biotechnology and bioeconomy, was completed in June 2015. The government has extended the roadmap to better take into account end-user needs to promote the development of products (e.g. bioplastics) and services rather than only intermediate goods in the value chain.

- *Finland.* The Strategic Government Programme of the Prime Minister and the Implementation of the Government Programme have been launched in 2015 based on five strategic priorities: i) Employment and Competitiveness; ii) knowledge and education; iii) wellbeing and healthcare; iv) bioeconomy and clean technologies; and v) digitalisation, experimentation and deregulation. The key projects on bioeconomy are: carbon-free, clean and renewable energy on cost-efficient basis; Wood and derivative products from forests; circular economy, and clean water projects. The new bioeconomy strategy involved extensive inter-ministerial co-operation and consultation with key research actors to ensure a systemic and comprehensive approach.

- *Korea*. A full-scale discussion on autonomous vehicles in Korea began with the announcement of "Autonomous Vehicle Service Commercialisation Support Measures" in the 3rd Regulatory Reform Ministerial Meeting held in May 2015 under the chairmanship of the President. Legislative and regulatory initiatives were thought to be important for facilitating system transformation. The existing regulations which prohibited the driving of autonomous vehicle on the public road at any case were relaxed in 2016 to allow test-driving of autonomous vehicle with the requirements of pre-test-driving, insurance coverage, and solutions against hacking. Raising public acceptance was also important. A demonstration event was organised in the centre of Seoul in 2015 where large public could see how autonomous vehicle could be operated on the road and react to the unexpected surroundings that could lead to the fatal accidents.

- *Portugal*. Ocean energy is a potentially important area of activity for Portugal that has good natural resources, particularly in what concerns wave energy. The broad strategic objectives and the narrative of future benefits to be achieved were stated in the National Energy Strategy 2020 that defined the goals for the various renewable energy technologies and in the National Strategy for the Sea (2013-2020). The policy mix for ocean energy challenges includes different types of systemic policy instruments: pilot and demonstration support, regulatory measures combined with demand-side mechanisms and more traditional R&D support. A Pilot Zone for Wave Energy provides the essential infrastructure for the experimental activities and the setting for a comprehensive regulatory framework for the production of electricity from waves.

- *Sweden:* The *Re:Source* initiative, one of Sweden's 16 Strategic Innovation Programmes (SIPs) provides long-term support for system transformation by supporting innovative business and governance models for transition to a circular economy, promoting expanded lifespan of products, efficient logistics for materials feeding into the circular economy, waste prevention strategies for production and reuse of products and components, improved awareness and attitudes among consumers, improved markets for reuse of products, de-poisoned circular material flows, efficient and economically sustainable energy production based on biological processes, improved work environment, health and security. The first phase was initiated 2016 and will last three years but from the beginning, consortia actors have planned for a twelve year duration.

The emergence of cities as actors in the transition to sustainability has given rise to a range of smart cities initiatives such as Finland's National Innovative Cities (INKA) programme; the Tekes Witty City programme and Germany's National Platform for Future Cities, whose overall goal is to make cities CO_2-neutral, energy-efficient and climate-adapted. Major stakeholders in this process are city administrations, research institutes, companies and the central government. Improved governance mechanisms and better means of engaging a range of stakeholders are needed to facilitate system innovation.

- *Japan*. The Ministry of Economy, Trade and Industry (METI) reviewed four large-scale smart city demonstration projects in different areas of Japan which were called "Next-Generation Energy and Social Systems Demonstration Areas" and launched the Virtual Power Plant Demonstration project in 2016 to demonstrate business models in smart cities. Policy and institutional measures for facilitating communication and engagement with end-users have been particularly important in the development of innovation for smart cities. One example is the Japan Smart Community Alliance (JSCA), established in April 2010, which aims to resolve the obstacles faced by individual organisations through collaboration between the public and private sectors.

- *Finland* and *the Netherlands* have used public-private partnerships as a means to foster co-ordination and alignment [Strategic Centres for Science, Technology and Innovation (SHOKs) in Finland and the Top Sectors approach in the Netherlands].

- *United Kingdom*. To improve the impact of government interventions on environmental challenges and to facilitate the transition to a low carbon economy, the UK Low Carbon Innovation Co-ordination Group co-ordinates the efforts of organisations with public-sector backing. Collectively the group's members are expected to spend over USD 1.45 billion PPP (GBP 1 billion) on related innovation activities. In Germany, initiatives such as the *Energiewende* Research Forum, the *Koordinierungskreis Forschung* and the Science Academies' "Energy Systems of the Future" Project foster dialogue and co-ordination of research, government, society and industry stakeholders for the common goal of transforming the energy system.

References and further reading

Coenen L. et al. (2016, forthcoming), *Policy for system innovation – the Case of Strategic Innovation Programs in Sweden. OECD case studies on system transformation*.

EC (European Commission)/OECD (forthcoming), International Database on Science, Technology and Innovation Policy (STIP), edition 2016, www.innovationpolicyplatform.org/sti-policy-database.

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

Kergroach, S., J. Chicot, C. Petroli, J. Pruess, C. van OOijen, N. Ono, I. Perianez-Forte, T. Watanabe, S. Fraccola and B. Serve, (forthcoming), "Mapping the policy mix for innovation: the OECD STI Outlook and the EC/OECD International STIP Database", OECD Science, Technology and Industry Working Papers.

Mulgan G. and C. Leadbeater (2013), "Systems Innovation. Discussion Paper", National Endowment for Science, Technology and ART (NESTA), London, www.nesta.org.uk/publications/systems-innovation-discussion-paper.

OECD (2013), "Systems innovation: Concepts, dynamics and governance", Working Party on Innovation and Technology Policy, internal document, OECD, Paris.

OECD (2013), *OECD Science, Technology and Industry Scoreboard 2013*, OECD Publishing, Paris. http://dx.doi.org/10.1787/sti_scoreboard-2013-en.

OECD (2017, forthcoming), *System Transformation: Policies for Implementation,* OECD Publishing, Paris.

Schot, J. and Kanger L. (2016) Deep Transitions: Emergence, acceleration, stabilization and directionality. Paper prepared for the SPRU 50th Anniversary. http://www.johanschot.com/wordpress/wp-content/uploads/2016/09/Deep_transition_2016.pdf.

Weber, M. and H. Rohracher (2012), "Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework", Research Policy, 41, pp. 1037-1047.