Innovation patterns for sustainability – Insights from a European Foresight Project on the Future of Innovation

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Abstract:

Sustainability is widely expected to become a major driver of innovation activities. Many companies adopt sustainability oriented innovation strategies and innovation policy on the national and EU level is increasingly targeting sustainability as "Grand Challenge". With respect to the environmental dimension of sustainability, the notion of "eco-innovation" that is directed at products, services and processes reducing harmful impact of production and consumption on the environment is becoming highly prominent in research, policy and industry. The paper rests on the findings of an international foresight project which investigates new forms of innovation such as open innovation and social innovation and their economic, social and environmental impacts. Based on these findings we show that we do not only need green products and services but rather "transformative innovation" towards systemic change in production and consumption patterns in order to achieve the step-change in reduction of environmental impact.

Keywords: Innovation patterns, new forms of innovation, sustainability, foresight, systemic innovation

1 Introduction

In the innovation management discourse there is substantial recent work on new innovation patterns such as open innovation, user driven innovation, distributed innovation, frugal innovation and design-driven innovation that are emerging in response to changes in the socio-economic framework conditions and new technological possibilities (e.g. Chesbrough 2003, von Hippel 2005, Howe 2006, Prahalad, C. K.,

Ramaswamy, V. 2004). In this strand of literature, however, implications for sustainability are rarely explicitly considered.

At the same time sustainability research has developed a number of concepts to orient innovation activities towards sustainability. Most prominently the notion of "eco-innovation" (Bleischwitz et al. 2009) comprises product, process and system-innovation for sustainability.[1] Substantial efforts are made in understanding, measuring and supporting eco-innovation (e.g. OECD 2009).

On the one hand there is a clear need for eco-innovation for new products and services in fields such as energy, environmental technologies as well as resource efficiency. Globally, "Green markets" are expected to expand heavily. At the same time the need for systemic eco-innovations that underpin a transition in established consumption patterns is increasingly being emphasised. Sustainability as a driver of change in innovation patterns implies much more than just directing innovation efforts towards green products and services as it is already done in many innovation policy programmes. Rather, the innovation patterns themselves need to change to enable transformative innovations (Steward 2008) that underpin system transitions which can only be achieved through social and technological innovation in close alignment. Such necessary transformations have been investigated from the theoretical perspective within the literature explaining transitions of socio-technical and even socio-ecological systems (Geels 2005).

Also some business actors such as the World Economic Forum have pointed out the need for structural transformation of value creation patterns.[2] In particular the solutions for the functions with the highest impact on the rapid deterioration of the earth's ecosystems services mobility, food and housing (Tukker et al. 2010) need to be reconfigured in order to achieve the required reduction of ecological footprint.

In the realm of innovation policy a number of concepts are being proposed for initiating, fostering and speeding-up such transitions. Concepts like "transition management" (Kemp et al. 2007) and "reflexive governance" (Voß et al. 2006) have been suggested. Recent RTI policy strategies most notably the European Commission's Europe2020 Strategy (EU 2010) explicitly aim at addressing the "grand challenges of our time" with "transition towards a low carbon economy" at the core.[3]

Many authors stress that "transformative innovations" require not only new innovation targets but also new innovation patterns. While this may be true for a number of innovation activities aiming to address societal challenges such as health and security, in the case of eco-innovation it is at the core of the problem. Only an alignment of social and technical innovation is able to achieve transformations without "rebound effects" that immediately counteract the environmental benefits as it has often been the case in the past. Such an alignment however cannot be managed through traditional innovation patterns that are primarily targeting new products and processes and their embedding into existing societal patterns. As social systems are hyper-complex it is impossible to predict beforehand how new products and services will be embedded into social routines and what will be the environmental impact of the new socio-technical configurations. "Collective experimentation" a concept that has long been discussed in the realm of Science and Technology Studies (STS) is being proposed as a means of exploring sustainable innovation pathways (Joly et al. 2010). Experimental methods like living labs, socio-technical scenario

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1 The full definition is "the creation of novel and competitively priced goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for everyone with a whole-life-cycle minimal use of natural resources (materials including energy and surface area) per unit output, and a minimal release of toxic substances" (ebd. p. 15)

2 "The world economy must move towards a "new normal", bringing about systemic change in consumption, production and the way in which value is created." World Economic Forum. Redesigning Business Value: A Roadmap for Sustainable Consumption. 2010 S,16 http://www.weforum.org/reports-results?fq=report%5Esocial%3A%22Sustainability%22 accessed May 2011

3 http://www.se2009.eu/en/meetings_news/2009/7/8/declaration_from_the_research_conference_in_lund_european_research_must_focus_on_the_grand_challenges

building or participatory technology development are being developed and tested for this purpose (e.g. Rennings 2000).

However, apart from these policy oriented concepts, there is little understanding of patterns and methods related to transformative eco-innovation when they are not set up by public policy programmes. Often it seems it is just assumed that more open and distributed innovation patterns will automatically bring about sustainable and demand oriented innovations (EC 2007).

In this paper we would like to explore in more depth the relation between sustainability innovation and innovation patterns. For this purpose we build on the findings of a recent EU funded Foresight project on future innovation patterns (INFU Innovation Futures). On the basis of the INFU findings we investigate if and how targeting sustainability may change the way innovation is organised and to what extent recently proposed innovation models such as open innovation and user innovation are able to underpin a sustainable development.

2 The Innovation Futures Foresight project

Research question

The Innovation Futures (INFU) project[4] is a foresight exercise which deals with the emergence of new innovation patterns such as newly emerging principles of organising innovation processes, the involvement of new actors as well as new functions and meanings associated with innovation. Accordingly, we explore how the process of the creation, development and introduction of innovations is changing in business, society and public sector. While some new innovation patterns such as open innovation or user driven innovations have been discussed intensively in recent years, others such as "software driven innovation" have received much less attention. Also, there is little systematic exploration about possible future innovation landscapes and implications for economy and society. Therefore INFU is aiming to contribute some insights on possible pathways for the future of innovation.

The emergence of new innovation patterns and change of the innovation landscape is not necessarily a radical one. Hence, INFU is not only looking at completely novel concepts, ideas and strategies, but also at some well-known trends such as open source software development, which are already prominent in specific industries or areas, but may also have a larger impact or potential for other areas in the future where they are still "new" today.

Approach

As a foresight project INFU is engaging innovation actors with a wide range of diverse backgrounds into a structured dialogue on possible future innovation pathways. For this purpose the project team deploys various foresight methods such as weak signal scanning, expert panels, expert interviews, vision- and scenario building as well as visualisation techniques in order to imagine potential future innovation landscapes.

Signals for change in innovation patterns

Based on an analysis of various sources such as blogs, newspapers, company announcements, research projects and magazines, signals for arising change in innovation patterns were identified in the first phase of the project (Dönitz et al. 2009). Each signal was described and assessed in a template and posted on the INFU signal scanning blog.

In parallel, a review of recent academic literature suggesting newly emerging innovation patterns was carried out. Concepts suggested by academics to characterise these changes such as open innovation, user innovation, value innovation, crowdsourcing, design innovation, soft innovation, user generated content,

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4 The Innovation Future project is funded within the 7th Framework Programme by the European Commission. See www.innovation-futures.org for the project web page.

commons based peer production and social innovation were listed and very briefly summarized (Dönitz et al 2009). Drawing on both sources of information, clusters of interesting changes were formed and nineteen clusters were selected for further consideration.

Amplified signals – Nineteen Visions

The INFU research team further developed the selected clusters into nineteen provocative innovation visions. For this purpose the team use three different means of "amplification": Transfer of the signal to other realms (e.g. different sectors), generalisation from few pioneering applications to mainstream practice and radicalisation.[5] In a next step we conducted interviews with innovation actors from industry, society and academia and organised an online-survey to discuss and assess the visions.

Eight consolidated visions

On the base of this assessment, in the second stage of the project eight "nodes of change in innovation patterns" were identified by clustering and consolidating the original 19 visions on the base of the assessments voiced in the interviews and the survey. For each of these "nodes of change" a mini-panel was set-up co-ordinated by a person who had contributed interesting insights in the assessment phase. The coordinators were then involving larger groups of 5 – 15 people. These mini-panels developed eight consolidated innovation visions. Table 1 gives an overview of all mini-panels and their coordinators.

Table 1. Overview of visions discussed by mini-panels

Innovation vision	*Coordinator*	*Organisation/Country*	*Approach*
Open Source Innocamp Society	Dominik Wind	Until we see new land (Innovation camp Start-Up), Germany	Workshop with stakeholders of future innovation camps
Automatising innovation	Patrick Corsi	Consultant and Innovation Management Lecturer, Belgium	Interviews with key and group telephone discussion
Ubiquitous Innovation	Rolandas Strazdas	Professor innovation management, company consultant, Lithuania	Creative session with innovation management experts (Vilnius)
Innovation chain management	Anna Trifilova and Bettina von Stamm	Professors Innovation Management; Innovation Leadership Forum, Russia and UK	Three seminars in the framework of international conferences with researchers and company representatives
Waste Based innovation	Jay Cousins	Founder of Open Design City Berlin, Germany	Workshop in Berlin with stakeholders and key actors from cradle to cradle community
Deliberative innovation	Anders Jacobi	Danish Board of Technology, Denmark	Visioning session among CIVISTI
City-driven systemic innovation	Daniel Kaplan	FING - association pour la Fondation	Workshop envisioning the "open

[5] See also a short video about the 19 innovation visions on the INFU web page: www.innovation-futures.org

		Internet Nouvelle Génération The Next Generation Internet Foundation, France	innovation city" with actors from city councils and companies involved with city level innovation
Social experimentation	Stéphane Vincent	La 27e Région, France	Drafting of Citizens Agency in a visioning session with actors in social innovation

Source: Own depiction.

The idea and main topics discussed for these eight innovation visions are briefly described:

The innovation vision *Open Source Innovation Camp Society* is centred on the idea that innovation camps, where people gather for specific innovation tasks for a certain time are becoming increasingly popular. Often the idea is linked to the open source society, where a number of products and services are developed in close interaction among users. In the mini-panel the original idea was further developed into a landscape where such innovation camps are common as a means of problem solving for companies, communities and public sector organisations.

Automatising innovation assumes that a number of new techniques such as semantic web analysis allow for automatising parts of the innovation process from idea generation via design to testing. In the mini-panel it was outlined how this could gradually emerge.

Ubiquitous innovation is becoming mandatory for more and more people in companies and other types of organisations. However, in this respect the question arises how we can avoid "innovation overload", "innovation fatigue" and "innovation divide"? What does it mean to live in an environment that is constantly innovating? The mini-panel developed the counter-image of „widespread creativity", where all creativity depends on personal attitude rather than on professional background and innovation becomes a widespread everyday competence.

Innovation chain integration is a further innovation model based on the observation that there is a new spatial distribution of innovation emerging. What will be the mechanisms to integrate all the distributed and diverse elements and to match ideas and solutions with problems and needs? The mini-panel came up with a number of suggestions for boundary spanners such as innovation-chain masters.

Waste-Based Innovation is explicitly dealing with the issue of sustainable production and consumption patterns and the emergence of an innovation patterns that are fully consistent with a circular flow of resources following the "cradle2cradle principle" (Braungart and McDonough 2006) and novelties emerge out of used products. This vision was unanimously assessed as the most desirable throughout the INFU interviews and survey while at the same time severe barriers were pointed out in the near future. The mini-panel led by Jay Cousins from Open Design city outlined a consistent image of infrastructures, enabling technologies and archetypical actors associated with this pattern.

In the innovation visions *Deliberative innovation* it is expected that citizens will play a more important role both in governing and implementing innovation activities, this innovation model is driven by citizens and can be best described as bottom-up innovation. It was argued that innovation will be either initiated by public actors to address societal challenges through joint of all societal actors or else emerge from citizens proposals.

Cities are increasingly expected to play a major role as innovation drivers expressed by the vision *City-driven innovation*. In particular, systemic sustainability innovations may best be implemented on a city level. What are adequate mechanisms for cities to reap the benefits of this potential?

Social experimentation is more and more recognised as highly relevant for developing innovative solutions addressing societal challenges. New modes of innovation are required to align social and techno-

logical innovation activities. Participatory experimentation and social innovation will play a key role in the future, however, what are the right instruments and levels required for successful solutioning?

Assessment workshop

After the closing of the visioning phase a workshop was held where the visions' implications for the quality of life of citizens were assessed by experts and stakeholders from different realms such as working life, environment, business and regional development. This process is till ongoing.

Overarching findings

Each vision is addressing distinctive phenomena and issues and representing different stakeholder perspectives. However, changes in innovation patterns emerging from the INFU visions can be assigned to three dimensions: coordination mechanisms, nature of outcomes and innovation motives (c.f. figure 1).

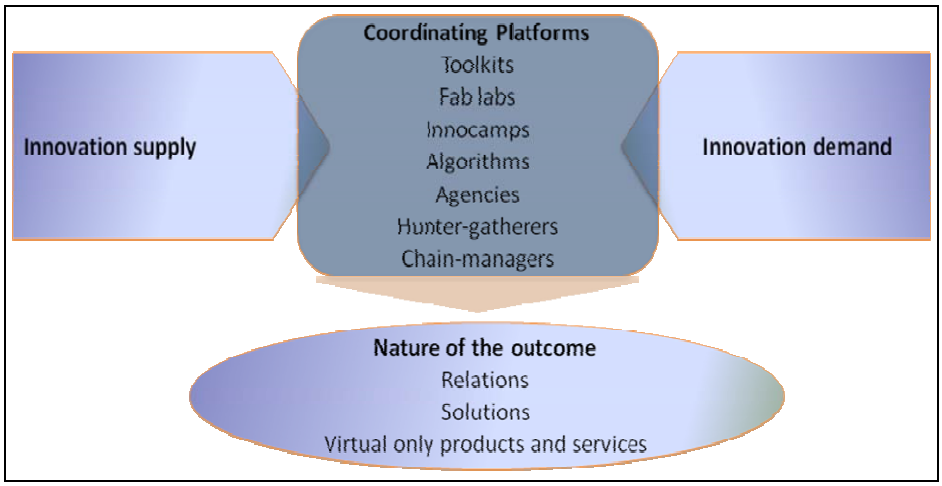

Figure 1: Elements of future innovation patterns by INFU

All visions are incorporating fundamental **changes in the mechanisms mediating between innovation demand and innovation supply**. In most cases, the role of companies as dominant broker between needs and solutions is seen to be shrinking and more direct involvement of individual or (more often) collective innovation users is described. A wide variety of hybrid value creation business models is being proposed. According to several visions, participation is gaining importance in the process of expressing and structuring innovation demand as well as in the process of innovation supply. The issue of finding the right level for mediating and enabling platforms between innovation demand and innovation supply is addressed in several visions.

Secondly, most visions describe a change in the **nature of the outcomes of innovation.** Forming of identities and relations as well a social innovations are widely expected to gain relevance as innovation target. Immaterial aspects of innovations are of growing importance, too.

Furthermore, the discussion among the experts revealed the emergence of additional **motives for innovation activities**. Most visions emphasise the need to address societal challenges and in particular environmental issues as a key driver of change not only for the target of innovation but also for innovation patterns. But also the desire to improve quality of life, social cohesion and to address community issues was emphasised as innovation motive across sectors.

New forms of innovation and sustainability

Sustainability was pertinent as a driver of change in innovation patterns in practically all INFU discussions from the bilateral interviews to the Mini-Panel group debates, independently from the core topic of the conservation. In almost all of the above described innovation visions sustainability issues were discussed and several interesting observations emerged.

In particular three visions explicitly dealt with sustainability innovation:

The vision of "**waste based innovation**" which describes a cradle-to-cradle waste-free innovation paradigm had been unanimously assessed as the most relevant and desirable by experts from academia, business and citizens alike. At the same time major obstacles were seen for its realisation. Nevertheless, in the respective Mini-Panel a consistent long-term future image was generated out of this vision. The innovation landscape sketched in this mini-panel contained three systems that were closely interrelated: the "on demand economy", the "surplus ecosystem" and the "access culture". The "surplus ecosystem was close to the original vision of waste based innovation and described an innovation paradigm focussing on creating novelties out of existing products. In the subsequent assessment workshop it was emphasised that such a paradigm of "waste based innovation" is suitable as a transition paradigm towards a circular economy where resource flows are fully circular and tailored to demand without any "waste stages". It was warned that too much emphasis on producing new things from old ones may create a lock-in situation and hinder the speedy transition towards the circular economy. At the same time the phase waste based innovation may yield valuable learning that will underpin a cultural transition towards the circular economy.

As outline above one of the key aspects of sustainability transition is systemic eco-innovation i.e. fundamental change of the way human needs such as shelter, food and mobility are addressed. There is still little understanding how such systemic innovations can actively be fostered. One possible pathway was outlined within the mini-panel that worked on the INFU vision "city driven systemic innovation". This vision had originally described a situation where cities enforce systemic innovation in a rather top-down manner. Nevertheless in the Mini-Panel that was formed by a group of city level actors some of them with a solid background in participatory governance approaches the image was transformed into a notion of **"open innovation city"** which is thought to be much better equipped to achieve sustainability innovation. It was argued that successful sustainability innovation requires an open, user-driven approach.

Experts within the mini-panel on **"social experimentation"** that were exploring participatory bottom-up forms of social innovation argued that they were confronted to a series of trade-offs. Supporting small and specific groups individually for long periods as required by social change is an economically unsustainable process. Forms of up-scaling should be found either by translating part of the experts' knowledge into toolkits to be reused in similar situations or by teaching people part of the experts' professional competences. In both cases the challenge for experts is to transfer their skills in order to enable citizens to autonomously improve and disseminate their own initiatives. This introduces a second trade-off where experts should give up their expertise position (something that they are generally reluctant to do) and acquire teaching and coaching capabilities to be able to effectively transfer their knowledge. In addition, some experts argued that high levels of participation tend to produce average quality. Compromising to include all range of social requirements hence may reveal lukewarm solutions. On the other hand strong project statement and decision-making tend to weaker participation and discourage engagement. The current increased focus on participative innovation is now a clear reaction to excessive bottom-up approaches and result in the belief that the solution is entirely contained in the grassroots population. A more mature approach would overcome this somewhat simplistic opposition to combine professional specific skills and user experience.

The panel concluded that social changes and transformation in complex and multi-dimensional issues such as sustainable transition could benefit from multiples experimental micro-projects involving participation of local stakeholders to stimulate, try and debug new ideas. Equally important is the fact that these local experimentations should be strongly connected to learn one from the other, sediment lessons learned and continuously transform interaction and regulation processes between stakeholders. The question of the adequate level and format of enabling platforms for problem oriented socio-technical innovation was

highlighted also in other mini-panels. Different suggestions were developed such as innovation camps as standard means of problem solving for communities and companies alike.

Conclusions

The INFU finding give rise to two major conclusions with respect to sustainability and innovation patterns: The rise of participatory elements and the emergence of hybrid innovation models. For both cases however INFU revealed a complex and ambiguous rather than one-dimensional relationship to sustainability.

All INFU visions that described successful sustainability transitions also featured innovation patterns with strong **involvement of citizens and users**. This implies that most likely sustainable innovation landscapes will embrace strong participatory elements. Thus, if indeed company strategies are moving towards user-centric innovation as suggested by some scholars (Prahalad & Ramaswamy 2004) these companies are most likely better prepared for sustainable innovation landscapes.

The other way round however, there are no indications that a wide adoption of open innovation will automatically foster sustainability transition. In the contrary even the mini-panel with a very strong focus on participatory "social experimentation" is warning that fully bottom up participation alone is not likely to bring about the system changes required in particular if the enabling platforms are organised on an extremely individual level. It is also warned that putting the full responsibility of community governance on citizens without providing the adequate means is not likely to bring about a sustainable innovation culture. Accordingly, the groups that dealt with "open innovation city", "deliberative innovation" and "Innocamp society" describe elements of an enabling infrastructure that allows innovation to emerge from joint experimentation of business, private and public actors. The provision of this infrastructure seems to require strong macro level governance.

Secondly, the INFU findings indicate that in sustainable innovation landscapes business driven innovation will only be one element of the "transition" towards a new way of fulfilling basic needs and the organisation of production and consumption. In particular it seems likely that part of the value creation that is now performed by companies will be provided through other mechanisms such as direct interaction between knowledgeable users.

Finally, according to the INFU findings it seems likely that elements of local self production will play a role in future innovation landscapes. Here, even more than in the case of open innovation there is no automatic sustainability gain. On the contrary, scenarios of fully individualised self-production (Gershenfeld 2005) may well be problematic in terms of sustainability. Some of the INFU panels – in particular the "waste based innovation" one, describe which kind of configurations may be required for such "fab labs" to function as part of sustainable innovation infrastructure.

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