Policy Strategy Report

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1 Introduction

INFU is a foresight project which develops plausible and relevant long-term scenarios of future innovation landscapes in order to orient long-term strategy-building for policy and other innovation actors. The project implements a progressive explorative dialogue with key stakeholders and experts using advanced creativity methods to foster thinking beyond established pathways.

In this report we draw conclusions for policy based on the previous INFU work packages. This is done by discussing and assessing eight dimensions of change in innovation patterns. The dimensions of change aim to describe those key characteristics which are common to most of the emerging innovation patterns we have synthesised within the INFU project.[1] A specific workshop was organised in December 2011 to discuss implications for policy involving representatives from different Directorates General of the European Commission, the OECD and Member States. In addition, interviews with policy-makers and companies have been conducted to discuss specific conclusions.

We will first give an overview of the eight dimensions of change (Chapter 2) and will then describe in more detail challenges and implications for policy related to each dimension of change. In Chapter 3 we will analyse some recent innovation policy documents from the EU and the OECD to examine to what extent policy already responds to some of the most important challenges resulting from emerging new innovation patterns. The task is not to give a full analysis of current innovation policy strategies, but to identify to what extent new patterns of innovation are addressed in the most prominent strategy documents. In Chapter 4 we will summarise the most important findings.

2 Dimensions of Change in Innovation Patterns: Overview

The following dimensions of change in innovation patterns emerged as common features across the many different changes in ways of conducting innovation observed in the INFU project:

(1) Mediation and coordination: The position of markets as *the* main mediator between innovation demand and supply is challenged by several new innovation patterns. Other coordination mechanisms such as self-organised communities or web-based co-design platforms are on the rise.

(2) Participation: Citizens and customers seem to play a more relevant role in innovation, both in deciding on innovation priorities and in contributing to the innovation process. Finding the right level and instruments to enable this kind of co-creation of solutions seems a crucial future challenge.

(3) Motivation: The motivation for innovation is changing. Company profit as the main driver of innovation activity is being complemented. Solving societal problems is becoming an important driving force to innovate, for both companies and individuals. In addition, individual actors are motivated to contribute to innovation activities (such as crowdsourcing initiatives or idea competitions) for their pleasure.

(4) Automatisation: Software will play an ever-growing role in innovation. More and more innovation steps may become automatised (e.g. by using a web crawler to identify ideas).

[1] For more details, see the INFU deliverables, which can be downloaded from the INFU web page: www.innovation-futures.org. In particular see: Warnke, P., Schirrmeister, E. (2011): Scenario Assessment Report, Deliverable 5.1, November 2011.

(5) Infrastructures: New innovation enabling infrastructures to emerge alongside new innovation formats. In particular enabling infrastructures for community innovation, such as innovation camps, shared fab-labs and co-working spaces are likely to become more important. In addition, virtual/digital global innovation infrastructures may be increasingly required.

(6) Perception of creativity: The very meaning of being innovative is shifting. Creativity may become a key aspect in all professional activities. Formation of identities and social relations as well as everyday creativity may increasingly be recognised as core aspects of innovation.

(7) Spatial shifts: Innovation will change its spatial patterns. Local elements are likely to gain relevance, resulting in a more distributed innovation scenery. At the same time, new regions emerge as key actors in global innovation chains.

(8) Systemic sustainability innovation: Innovation patterns fostering system transitions towards sustainability rather than isolated product development become more and more important in order to address the grand challenges. This requires, for example, that social and ecological criteria are considered during the entire innovation process, e.g. by designing circular resource flows (cradle-to-cradle).

In addition to these eight dimensions changes in **learning and education** were assessed as extremely important by all participants during all stages of the INFU foresight. However, we discuss them as a policy action line and not as a separate dimension of change as they are associated with practically all dimensions of change in innovation patterns.

In the following we will describe challenges and implications for policy for each dimension of change. Therefore we will first summarise some significant threats and opportunities for each dimension of change as brought forward by experts in the INFU workshops and interviews. The development of policy conclusions is hence guided by the idea that policy should exploit and unfold opportunities of new innovation models on the one hand, and avoid risks and negative impacts on the other hand.

3 Dimensions of Change: Assessment and Policy Implications

3.1 Dimension of change 1: Mediation and coordination

The position of monetary-based market mechanisms as *the* main mediator between innovation demand and supply is challenged by several new innovation patterns. We can observe new mediation mechanisms such as self-organised communities, web-based co-design platforms, or innovation initiatives on the city level involving public and private actors that all operate with different “currencies”.

Some of the most significant opportunities are:

- If we are able to harness the ‘wisdom of the crowd’ more and better ideas become available.
- A new ‘constructive power of coordination’ (enabled through charismatic leadership) may be emerging.
- There is a high potential for new business opportunities from providing services and products around these above sketched new innovation patterns
- Some of today’s barriers to profit-oriented product innovation will disappear. Traditional economic “power structures” may erode due to easy transfer of solutions and absence of patenting.

- The open source society will offer new opportunities for start-up companies, requiring less start-up capital.

The most prominent threats are:

- Society may suffer from an overload of ideas without adequate mechanisms to process, filter and implement them and a lack of standardisation and legislation. A permanent state of experimentation may induce an ever changing / never working system, which is especially challenging for the elderly.
- Companies externalising the risks that are connected with innovations by using open innovation approaches may not compensate the innovators sufficiently. This might lead to the emergence of the "creative poor".
- Resistance to these new forms of mediation may emerge inside the companies if employees feel challenged by new external forms of innovation.
- There are too many policy levels and local structures supporting innovation, competing more than collaborating and reducing efficiency and readability of the support resources.
- Companies may not be able to exploit these opportunities due to a lack of required competences. In particular, many companies lack the cultural competencies to interact with the actors of these new formats and do not have the currency required to act in these types of markets.

Implications for policy

At the *policy level,* the emergence of new mediation mechanisms require a policy that takes a leading part in making new forms and patterns of innovations more visible and therefore also eligible for funding. Accordingly, more need for coordination between different policies and policy levels and hence efficient and effective governance is needed (multi-level governance). This need holds especially true when we call for more systemic innovations: Policy coordination has to be enforced and different instruments from different policy realms need to be aligned. A new form of system-integrator for systemic innovations therefore also is required and non-engineering, non-natural sciences competences from the humanities should be included in the innovation process. Moreover, especially at the regional and urban level, policy has to consider whether or not to play a much more active role as a proactive mediator.

Policy should enable all actors to participate and avoid exclusion. In addition, policy should initiate projects with new formats involving very different actors from many realms. If individuals (laymen, citizens, users) or groups of individuals, who for instance organise themselves in innovation camps, become eligible for funding, new target groups for RTI policy come into focus. Existing policy measures that address innovation management and coordination activities e.g. via projects, advice, services and platforms would get new focus and spin. It would also become more complex if not only companies but also individuals are eligible for funding.

This change in the innovation actor landscape and in the forms of interaction surrounding innovation activities also poses challenges to existing forms of regulation. When innovation also comes from individuals and not just from companies, rules and norms about the ownership of innovation (Intellectual Property Rights - IPR) and product liability have to be further developed and adapted. Additionally, it is also necessary to find solutions and norms for a fair distribution of profits between organisations and individuals (e.g. crowdsourcing) which at the same time does not crowd out motivation (see also dimension 3). Policy therefore should help to establish clear and transparent rules for these types of new markets including remuneration, IPR and liability issues in a similar way as for other types of transfer

markets. Several examples such as creative commons, copyleft, and the flexible purpose corporation[2] are new trends which can be mentioned in this context.

3.2 Dimension of Change 2: Participation

The role of citizens seems to be gaining relevance in innovation, both in deciding on innovation priorities and in contributing to the innovation process.

Some of the most significant opportunities are:

- Radically open, participatory innovation landscapes will allow the empowerment of citizens, employees and customers, foster creativity and idea generation. Radical innovations will be encouraged as people are ready to take bolder risks.
- Direct feedback of participation through local implementation and closed loops between projects and benefits will be rewarding to all actors. Mobilisation of the critical mass of stakeholders may enable finding breakthrough systemic solutions to societal challenges.
- Opening up innovation patterns towards contributions and assessments from many actors improves the context-specific relevance of innovations and assessment of ecological soundness. Rebound effects are reduced through close interaction between innovation promoters and opinion leaders.
- The change of policy-maker's role from "decision-maker" towards participation facilitator, moderator and stimulator may foster more problem-oriented politics.
- Avoidance of strong social conflicts on technological development (i.e. genetically modified organism, nanotechnology, ...) that may occur if citizens are not involved in the deliberation on research and technology.

At the same time, we can observe some threats, amongst others:

- Participatory processes might hinder long-term transition towards a more sustainable ecosystem because negative short-term effects at an individual level are not accepted by the majority or at least some parts of society (slogans such as nimby ("Not in my backyard") and banana ("build absolutely nothing anywhere near anybody") indicate this development). Society may become locked into its current status.
- Many requests for time-consuming participation in innovation processes and heavy responsibility may result in a participation fatigue which makes it increasingly difficult to involve people.
- Discrimination may occur between small elites with the time, attitudes and resources available to participate, and the rest of the population.
- Pseudo involvement may emerge which leads to only superficial adjustments whereas the true power mechanisms are hidden behind a "participatory facade". Such participation for its own sake leads to participation fatigue in the long run.
- For export-oriented companies that become heavily involved in participatory innovation in home markets, there is a danger of lock-in into local perceptions leading to Eurocentrism and failure to address the demands of global markets.
- If society at large becomes more participatory, many companies will experience major problems. As many of them are still very much operating in a "command and control mode" themselves, they will not be able to deal with demands from customers and employees raised in a participatory society.

[2] A Californian law from 2011 allows a corporation to integrate the for-profit philosophy of the traditional corporation with a *special purpose* mission that is similar to a charitable purpose.

Implications for policy
Policy may need to focus on the enabling framework for the four pillars of the innovation system (quadruple helix[3]): the co-evolution of government, knowledge institutions, industry, and civil society. This implies a change in the role of policy-makers towards mediators within a wide range of coordination processes.

Finding the right level, scale and instruments to enable participatory co-creation of solutions seems a crucial future policy challenge. Adequate consultation processes where people are motivated to contribute must be developed. Participatory procedures that fit today's modes of group interaction such as web 2.0 procedures (e.g. facebook, twitter) should be developed, tested and deployed. Normative and exploratory forward-looking activities where actors jointly develop shared visions, debate values and possible pathways and solutions could become a standard policy instrument. Such processes may be key in avoiding the risk of a "participation-induced" lock-in into today's situation due to lack of long-term orientation on the part of today's actors.

Nevertheless, there is no "one-size-fits-all" participation mode. Participation procedures need to be tailored to different phases of the policy process, such as: idea generation, visioning, up-scaling, co-production of solutions, political involvement, funding through citizens. Also, the right scale for participation needs to be carefully adapted. Not everybody can be an expert in everything and too many requests for contribution will lead to overload and fatigue.

Citizens' activities that are now often bogged down in protesting could be channelled into co-solution-finding activities if adequate instruments were available. Different actors should be supported in engaging in participatory solutioning. Both large and small companies need to build up respective competences. Policies should support SMEs moving towards collaboration and sharing innovation equipment; regulatory frameworks should create a safe environment for co-inventing and developing.

Innovation policy should consider funding more heterogeneous consortia with "lay people"/users also in leading roles, as well as new formats such as cross-cultural innovation camps and user research to define societal needs as the first step instead of the last.

3.3 Dimension of Change 3: Motivation

The motivation of organisations and individuals to develop innovation is changing. Company profit as the main driver of innovation activity is being complemented. Solving social problems becomes an important driving force to innovate, for both companies and individuals. In addition, individual persons are motivated to contribute to innovation activities, such as crowdsourcing initiatives or idea competitions for their pleasure.

Some of the most significant opportunities are:

- Changing motivation allows developing solutions which ultimately improve the quality of life.
- Value-driven innovation gives answers to major societal challenges.
- Services with attributes such as 'social' and 'caring' will no longer be regarded as nerdy and become attractive activities.
- The connection to social values prevents the attitude of indifference which allows following the slogan "hold the world in your own hand".
- New resources to finance the innovation system emerge which reduces the risks
- A strong motivation to solve social problems may overcome the time gap between short-term losses and long-term gains of systemic sustainability innovations.

[3] Involving civil society as important actor in the innovation process has been described as quadruple helix approach (Arnkil et al. 2010) referring and extending the well-known triple-helix approach from Etzkowitz and Leydesdorff (2000).

At the same time, we can observe also threats, amongst others:

- Companies that are now very much focussed on product innovation may experience problems in generating profits, as traditional product innovations will be less accepted.
- Changing motivation patterns increase the demand and complexity of policy coordination, as completely new policy realms such as social policy need to be involved into innovation policy-making.
- Changing motivation patterns may decrease economic wealth and growth as the outcomes of value-driven innovation will create a different kind of wealth (e.g. time). At the same time, shareholder expectations cannot be adjusted to less than 10% annual growth in turnover. Accordingly, conflicts between innovation actors will emerge.
- Resources for innovation policy may become contested as society may question the spending of taxpayers' money on research if there is no immediately obvious social benefit.
- A number of individuals may be competing in crowdsourcing activities under high pressure and low quality working conditions.

Implications for policy

New motivations require new and other solutions in different socio-economic realms, and therefore call for different forms of innovation (e.g. tangible and non-tangible, social and organisational) that address several individual and societal needs and challenges. This also leads to the need for policy innovation and coordination, aiming to include different sector policies, together with innovation policy matters. Needs and demand for innovation in the sector, and the sectoral innovation agenda could be defined and conducted by sector policy experts, coordinated via a systematic innovation policy framework.

The expanded circle of stakeholders and participants in innovation processes through new motivations to innovate (e.g. value-driven or even "fun-driven") demands new coordination mechanisms, often based on participatory processes and user involvement. Therefore, participatory processes involving policy-makers, citizens, users and lay persons should be eligible for funding to a larger extent than currently possible.

In addition, the direction of innovation development should be guided (giving orientation) by demand-side innovation policies such as i) public procurement, ii) objective-driven innovation policies, and iii) increased labelling and giving meaning to products and innovations.

Shifts of motivation towards societal needs also have consequences for demand-side innovation policies which become more important in this context as they can address specific societal challenges. Against this background, such policies should:

- enable first use, e.g. through subsidies for both the company promoting the innovation and a potential client that is willing to install and test the innovation and to demonstrate it to other potential clients;
- encourage first user clients, e.g. through support in buying a working prototype;
- Increase the innovation competences and capacities of communities, public organisations and infrastructure operators;
- integrate technical and social science research and innovation (both are weighted equally);
- create linkages between different projects that fit and contribute to the overall societal need;
- include stakeholders beyond superficial consultation and dialogue processes with citizens (trans-disciplinary research);
- show by means of "safe experimentation" with new innovation concepts that the new solutions work (proof of concept).

Moreover, non-commercial and social innovations together with changing motivation patterns also need new measurements and indicators, but also evaluation criteria and methods. The impact of innovations is not just economic growth, but e.g. changes in quality and well-being. Thus, non-monetary remuneration for innovation activities is required to validate such new forms of motivation and innovation. At the same time, motivation patterns to innovate also need a fair share of gained profits (monetary and non-monetary) to keep individuals going/motivated. This goes hand in hand with the upcoming change in growth paradigm and the measurement of wealth progress (more focus on life quality and not just increases in the numbers of innovations).

In this context, policy for social innovation and social entrepreneurship should be strengthened. Such companies have proved to be “profitable” in monetary and non-monetary terms. However, we still have to understand better how to support social innovation and social entrepreneurship and its relation traditional entrepreneurial activities mainly driven by seeking profits.

When innovation activities are no longer primarily directed at money-making, the current IPR system no longer fits the innovation landscape and hinders the transition towards co-designing landscapes that enable new forms of innovations. However, new strategies such as public domain, copyleft and creative commons help to transform the IPR systems and provide a safe base for experimentation.

3.4 Dimension of Change 4: Automatisation

Software will play an ever-growing role in innovation. More and more innovation steps may become automatised, e.g. by using a web crawler to identify ideas, but also by using simulation algorithms to generate ideas, to assess the market potentials of ideas, and to consider systemic implications, including environmental effects.

Some of the opportunities are:

- Automatised innovation processes may not only support individual employees by reducing the pressure to be creative, but also by setting free capacity for radical innovations.
- Algorithm-based innovation may underpin the handling of complexity and thereby support a transition towards improvements in society as a whole. With automatised innovation processes it may become possible to map the unknown and better meet consumer needs and preferences.
- With the increasing use of algorithms and web-based innovation elements the innovation process becomes faster and more efficient and effective. Fewer resources are required to produce new products and services and the merging of different fields can enable breakthroughs and thereby speed up the innovation process. Improved testing facilities will prevent failures.
- The dematerialisation of products and the transfer of innovation algorithms may bring about new business models for start-up companies.
- Increasing use of powerful algorithms allows complex systems to be more accurately assessed. Automatised innovation procedures will enable the exploitation of the vast amount of data created in the internet.

Associated threats are:

- A specific risk not only of automatised innovation but also of open innovation elements is data security and reliability. Criminal actors may threaten privacy and manipulate virtual systems by generating false preferences leading to negative effects in society and to reduced product quality. Privacy concerns may lead to information hiding and closure.

- Artificial intelligence needs to be controlled when values are involved and when it is closely connected to systems with significant impacts. Otherwise the damage resulting from system failures is too high.
- Superior knowledge of a few information technology experts may lead to a concentration of power and subsequent division of society. Job opportunities for the ‘educated’ and ‘medium-creative’ people may shrink.
- Algorithm-based innovation may lead to a lack of diversity in innovation. Consumers are locked in a bubble which is defined by their initial preferences; because information supply is automatically customised to their assumed preferences.
- Securing high quality input for the algorithms will be difficult (garbage in, garbage out). Reflection and creativity will be reduced if automatised innovation patterns become dominant.
- Software-based innovation patterns, in particular, when directly coupled with production or financing systems may bring about an economy with unlimited generation of ever new products at (risk of creating "8 million customised unicorns"). At the same time, radical systemic innovations may be hampered as automatised solutions will foster a preference for easy solutions.

Implications for policy

The automatisation of (parts of) the innovation and idea generation process (already) requires a systematic and automatised search for new ideas in digital sources and therefore a large amount of data processing.

Companies searching for valuable data e.g. via web crawlers, use this data in the innovation process. Quite often citizens, other companies, organisations and consumers are not aware that their individual data is used and further processed e.g. for business and commercial reasons. Misuse of personal data becomes an issue and a risk.

Against this background, a public debate and campaign could be initiated which reflects on the role and positioning of the individual in the information society and at the same time enhances individuals in positioning themselves in the digital reality as mature users and data providers. This debate has already started and can lead to *guiding principles* about data rights and processing that will become increasingly important in our societies. Only informed and mature consumers can deliberately avoid being “locked in a bubble” which is defined by their initial preferences. This effect can occur when extensively customised information, based on simulation algorithms, is provided to the customer for commercial reasons only.

With respect to the automatisation of the innovation process, ex-ante principles could guide the use of digital data for such innovation purposes and, at the same time, after relevant evidence has been collected, could lead to (ex-post) legislation and regulation without over-protecting and hindering automatised innovation.

Such stringent principles, for example, could guide and define IPR (owning and licensing the data), user rights and transparency of the data as well as the (fair) share of profit and value created with the data. Content policy (content provider versus content user), interoperability and standardisation issues to prevent monopolisation of data processing and storage should become issues of ever growing importance.

An open source strategy for specific data could support the successful handling of systemic complexity and thereby strengthen the transition towards improvements in society as a whole. Policy measures should reinforce the use of powerful algorithms for more accurate assessment of complex systems, supported by open availability of data. Simulation-based ex-ante evaluation of policy measures with respect to environmental and societal impact could be a positive effect of automatised innovation processes.

Policy actors will be asked to seek a balance between ensuring data security and transparency for individuals and organisations on the one hand, and enable more efficient and faster innovation processes by using simulation algorithms on the other hand. Thereby, evaluations of the effects of new products on society and environment can be done already at the beginning of new developments.

From a European innovation policy point of view it may be worth investigating to which extent and under which circumstances the inclusion of value considerations can be ensured for automatised innovation processes. Policy should be very aware of the risks of an increased automatisation of innovation and possible unintended long-term effects on creativity. Projects should be conducted to study the impact of information technologies and the internet on creativity and the direction and output of innovation activities.

3.5 Dimension of Change 5: New Infrastructures

New innovation enabling infrastructures emerge alongside new innovation formats. In particular, enabling infrastructures for community innovation such as innovation camps, shared fab-labs and co-working spaces are likely to become more important. In addition, virtual/digital global infrastructures may be increasingly required.

Opportunities in relation to this pattern are:

- This infrastructure may become the backbone of successful collective innovation towards sustainable solutions.
- It seems a highly promising opportunity for Europe to implement an enabling infrastructure to generate high value-added personalised products and service instead of competing with China in low-price mass production.
- Setting up this kind of innovation infrastructure could become a solution for some of the problems of urban development. Spaces that are now empty, such as obsolete office and industrial space could be revitalised by setting up innovation infrastructures.
- Collective innovation infrastructures may foster social cohesion as neighbourhood structures will be strengthened.
- The emergence of an innovation infrastructure for joint innovation between academia, industry *and* civil society[4] may be crucial for the success of future innovation ecosystems. These collective innovation infrastructures may nurture a new innovation culture that is better suited to meet future demands.

Associated threats can be summarised as follows:

- Open innovation infrastructures may form a very vulnerable system that is easy to hack. It may be attacked e.g. by Mafia-like organisations.
- Inability or time-lag of social systems to respond to the need for new social infrastructures.

Policy implications

This dimension affects several policy realms: in particular, innovation, environment, employment and urban development.

Policy should support the setting-up of such infrastructures (meeting places, living-labs, fab-labs, innocamps, etc.) with low entry barriers for people from all kinds of backgrounds and thereby enable widespread smart-bricolage and self-production beyond the “creative class”. Pilot projects could be funded within existing innovation funding schemes, but also new more experimental types of projects involving not only companies and researchers, but also civil society actors would be required. Old business parks and industrial sites could be used to set up these collective innovation infrastructures. Micro-grants and tax breaks could be used to

[4] See in this context also the reference to the quadruple helix approach (as discussed under dimension 2 above.

support people who want to organise such camps, fab-labs and other innovation infrastructure projects. Also, a regulatory framework including IPR solutions enabling such small-scale infrastructures should be put in place.

3.6 Dimension of Change 6: Perception of Creativity

The very meaning of being innovative is shifting. Creativity may become a key aspect in all professional activities. Formation of identities and social relations as well as everyday creativity may increasingly be recognised as core aspects of innovation.

Selected opportunities concerning this development are:

- With the emergence of everyday creativity, the gap between business and private life may shrink, job satisfaction increase, professions become “vocations” and value creation may become value appreciation.
- Education and training may benefit from a renewed emphasis on creativity and intuition.
- Quality of life and social cohesion will benefit.
- Ability to face the complexity of today’s life will be greatly enhanced.
- The wide spreading of creativity increases the number of ideas and potential solutions, including eco-innovations and even radical ones. New models of ownership and more durable products may become reality.

Some threats regarding these dimensions are:

- Too great an emphasis on innovation (innovation imperative) may result in creativity becoming a pressure for employees and thus ultimately kill creativity.
- Hyper-innovation can produce disappointment and uncritical rejection and thus stifle innovation.
- Widespread creativity and excessive emphasis on new products and ideas could speed up innovation processes and shorten product life cycles, so a more material-intensive world is created with the number of unnecessary, unsafe and unreliable products and the amount of waste increases.
- A landscape of extremely widespread and over-abundant creativity may pose some challenges for companies. Patterns featuring extreme flexibility of value propositions and complete openness of “innovation market places”, in particular when combined with an erosion of collective values, may become a threat to business. Due to lack of stability because of permanently changing conditions, companies may struggle to form an identity.
- Many people who will not be able to join in this landscape where people continuously need to re-define their identity will be left behind. A “creativity divide” may occur and form a threat to social cohesion.
- The traditional creative industry may lose its special role in the innovation process.

Implications for policy

In order to avoid stifling creativity, the emphasis of policy measures should be on appreciating creativity of all sorts, instead of enforcing specific types of ideas within a narrow framework. An approach is required which allows people to be creative in different roles and to build a bridge between professional and personal life. Regulation and administration should support creativity, both in the workplace and in everyday life. “Active jobs” with a high demand/high autonomy structure, flexible online work, a team-reward system, and non-hierarchical structures should be the rule. Europe should exploit its strength in process innovation through putting diverse project teams in place, and giving them an open space and a mandate for strategic innovation.

Moreover, awareness-raising is required as good examples suffer from lack of visibility and a l sense of urgency is also missing. In many professional areas creativity is not yet seen as something positive. Governments and the European Commission should set an example for the new world of work.

It is important to understand and exploit the creativity potential of different groups. For instance, creativity may be changing over the lifetime. Elderly people may have different creative abilities than younger ones, e.g. they may be bolder as they are less afraid of ruining their careers. In order to foster everyday creativity, we need supporting mechanisms for social innovation. Therefore, we firstly need a much better understanding of what social innovators need.

The key, however, towards a creative society lies in education. We need to learn in addition to formal education in order to acquire the skills to get along and perform well in society. Education should enable people from early on to approach things in a playful, experimental way. Education and innovation are closely tied together. Future education concepts will have to recognise the changing nature of innovation in order to enable young people to contribute to, and benefit from, the new innovation patterns. At the same time, change in innovation patterns will be driven by new forms of learning and identity-forming. Policy measures are needed to prevent large parts of society being left behind in such a development.

3.7 Dimension of Change 7: Spatial Shift

Innovation will change its spatial patterns: Local elements are likely to gain relevance, resulting in a better distributed innovation scenery where new regions become more important in global innovation chains.

Some of the most significant opportunities are:

- Localised participatory innovation settings may foster connectivity at neighbourhood level and bring about shared values, positive energy and thus enhance social cohesion and safety.
- Mobilisation of the critical mass of stakeholders may enable breakthrough systemic solution-finding for societal challenges.
- The change in the policy-maker's role from "decision-maker" to participation facilitator, moderator and stimulator will foster more problem-oriented politics. The focus on the local level may ensure a more practice-oriented education.
- Localised innovation patterns, such as open innovation platforms installed at a city level, may cater for a number of new business models such as developing half-finished products provided with local customisation services. The paradigm evokes a revival of the "old" model of local specialisation of production that is based on competence clusters or geophysical opportunities.
- Localised innovation patterns (e.g. city-driven innovation, deliberative innovation) allow for local resource flows and thereby reduced transport. Governing consumption patterns towards sustainability becomes easier, as people are more aware of local resource flows.
- Local participatory innovation patterns, in particular at the level of cities, enable positive resonance between human and technical systems and thereby breakthrough systemic (eco-)innovations. The local niche level may function as a test-bed for systemic solutions on a global scale.

At the same time, this development is associated with some threats:

- Local innovation patterns carry a risk of communitarianism and localism. Collective resource pooling and addressing global aspects may become difficult. Radical breakthrough innovations may be hampered in favour of incremental improvements.

- Localised innovation landscapes may block economies of scale. Strong differences between local specificities suggest the lack of global/mass markets and the need of flexibility for companies to adapt to local contexts.
- Explosion of ideas and projects at a local level without catalysts, boundary spanners, mediating platforms and adequate information sources may lead to inefficient processes at a macro level due to a lack of critical mass.
- An increasingly localised and distributed innovation (city-driven, social experimentation) landscape may suffer from a lack of broad and global views. There may be too much focus on the city scale, but insufficient consideration of what happens to the ecosystem at a global level.
- As people are not ready to pay an extra price for the local dimension, this pattern may prove not to be feasible economically (e.g. Amazon versus local bookshop).
- European R&D landscape may lose ground in global competition with Asia, due to regional fragmentation and relatively small budgets.

Implications for policy

Large companies from developed economies are increasingly globalising their R&D activities, and some emerging economies which traditionally played a secondary role in the global innovation landscape are catching up in developing their own innovative capabilities. These economies will offer their own innovations and products in the European markets and, at the same time, develop products which are aligned to their own needs and framework conditions, addressing customers with low income but high demand. At the same time, these emerging economies and markets have a great potential for European companies. On the one hand, European companies can choose reverse innovation strategies, delocalise the conception and production of low cost products and sell them worldwide. On the other hand, they should tailor their products to the requirements of these local contexts and emerging markets. Thus, policy should reduce barriers so that European companies can expand their R&D activities overseas and enable them to conduct global collaboration arrangements.

The globalisation of innovation and the emergence of new innovation players overseas challenges European industry. In order to tailor products, European industrial companies have to transcend their paradigms. Few engineers are able and willing to develop products for environments with poor infrastructures or low-tech solutions. A paradigm shift towards simple low-/mid-tech solutions for “the other 90 percent” that are easily adapted to very different contexts is very important. Policy can support this shift by raising awareness for this development. Also, “low-tech solutioning” should play a more prominent role in higher education.

In addition, systemic innovations for regional needs, developed in the region, will likely gain relevance. The regionalisation of systemic innovation activities will lead to (even more) emphasis of EU RTI policy on regional demonstration projects. Systemic innovations and solutions, e.g. addressing work organisation, transport, logistics and energy, will be demonstrated in different regions. Innovation competences visibly go to the public or public-related sector and the lead market concept would be realised in and enforced throughout the regions.

Given this shift towards regionally developed solutions, European policy will have to play a prominent role. It is not just about enabling and supporting (large-scale) demonstration and testing initiatives, but also to make sure that the results of such projects are transferable to other regions and markets, also outside the European Union. Policy should therefore support the development of services and measures that make such transfers possible and enhance the return of these investments. These measures would be more complex than just export support, due to the complexity of information transferred. Such measures are not sufficiently developed as yet. Additionally, policy support would then be awarded more to regions and

less to single companies, aimed also at overcoming the possible lack of systemic innovation competences at the local level.

A further development of the “smart specialisation strategy” is necessary to avoid all European regions focusing on the same sectors and diluting efforts to support innovation. Smart specialisation platforms, anticipation of local 'key enabling technologies' that need to be strengthened, strategic conversation about specialisation within regions, and matching EU support with regional subsidies can support this process.

3.8 Dimension of Change 8: Systemic Sustainability Innovation

Innovation patterns that foster system transitions towards sustainability rather than the isolated development of sustainable products are increasingly required in order to address the grand challenges of our times. This requires, for example, that social and ecological criteria are considered during the entire innovation process, e.g. by designing circular resource flows as realised by the cradle-to-cradle approach.

Opportunities:

- An industrial transformation including new forms of work will enable us to reduce our ecological footprint as required.
- Sustainable system innovation will bring about new business models and opportunities. Circular economy innovation patterns bring about multiple new ways for companies to earn money and to create new business. In this landscape "low-tech" can be a cash cow or a business model. New sectors may emerge and opportunities abound, in particular for agile SMEs operating on a local scale.
- Cradle-to-cradle elements in innovation patterns may bring about the new values, competencies and infrastructures required for an eco-consistent economy (emergent materialism). Traditional values such as appreciation of scarce resources may experience a revival.
- New professions will emerge, some of them characterised by highly skilled craftsmanship.
- Innovation patterns focussing on the re-use of existing products (waste-based innovation) have a huge potential to become a stepping stone on the road towards eco-consistent patterns of production and consumption and a fully eco-consistent economy.
- Consumers will turn towards value-oriented buying, knowledge-based choice-making and even frugality-thinking. Many of the problems created by the current production/ consumption paradigms (e.g. landfills) can be mitigated.

Threats

- Many of today’s companies lack the competencies required for system innovation, as they are very much focussed on individual products. There is still little awareness of the potential for profits arising from the whole system. This lack of competence may hamper the systemic paradigms and – in case it succeeds – will cause difficulties for a number of companies.
- New “eco-products” could lead to the prolongation of the existing consumption patterns, hinder a value change in society and become a barrier to transition processes.
- Circular economy innovation elements conflict with the growth paradigm that currently dominates global economies. If the concept is not implemented at a global level, the competitiveness of the respective countries and companies will suffer.
- Cradle-to-cradle innovation patterns may lead to a lock-in in a non-sustainable economic paradigm, if we fail to change the economic system towards a full cradle-to-cradle economy with a high degree of immaterial solutions to societal demands and

sustainable lifestyles. Also, several negative side effects, such as increased use of water, energy and transport may occur if the focus is too exclusively centred on waste avoidance.

- Innovation patterns with a high emphasis on resource re-use carry the risk of worsening working conditions. The number of low wage jobs with unhealthy working conditions may multiply, a global "waste divide" may emerge with some countries up-cycling the others' waste.
- Extreme re-use-oriented patterns carry the risk of emerging shadow economies with strongly negative consequences for the market and companies.

Implications for policy

If we are serious about addressing the "grand challenges", policy needs to support socio-technical system transitions. We need to break away from lock-in in non-sustainable socio-technical paradigms and underpin industrial transformation. Newly emerging industrial paradigms[5] should be explored and supported. This requires more than just a shift in priorities that is already underway in many strategies, such as EU2020. Several complementary measures are required.

Fostering systemic innovations is challenging for policy as it goes beyond just promoting individual "intelligent" projects, but it requires to adopting a really systemic view (comprehensive impact assessments, long-term strategy perspective, coordination of projects, existence of a system integrator ...).

To obtain successful system transition insights into society, lifestyle values and culture are as relevant as technological knowledge. Barriers and enablers rooted in social patterns need to be as well understood as technological challenges. One highly relevant case in point is sustainable urban development. Insights into the dynamics of density in cities could be a key element for achieving goals such as the "carbon-neutral city". To explore successful transition trajectories, we need to integrate perspectives from engineering and natural science, on the one hand, and humanities and social sciences on the other. To this end, research projects with this kind of trans-disciplinary collaboration on an equal footing should be explicitly supported. Furthermore, in order to understand and promote the societal benefit of new technological solutions, it will be necessary to extend RTI funding beyond the early stages of research towards the exploration of their societal embedding.

In addition, sustainability transitions require further development and application of systemic indicators for sustainability innovation. Such indicators will allow for holistic assessment of different trajectories and help to avoid funding of innovations with short-term local sustainability benefits, but negative global or long-term consequences. Sustainability standards such as cradle-to-cradle should be fostered and coordinated across nations. In the long run, all products could carry sustainability labels in a similar way as today's household appliances are labelled according to their energy efficiency.

Also, a new set of guiding indicators for innovation policy itself will be needed to realise the move towards a value-driven innovation policy paradigm. Judging the success of innovation systems may require more than just monitoring the number of patents and publications. Instead, the contribution of innovation activities towards the long-term quality of life would need to be taken into account.

Another crucial policy lever for system transition is a well coordinated systemic portfolio of measures. Innovation policy should actively create linkages between different activities and evaluate projects by their fit into the overall portfolio of activities. In order to ensure integration within funded projects, the involvement of organisations with a systemic

[5] E.g the blue economy, cradle-to-cradle, green economy, industrial ecology

perspective could in some cases be mandatory for research consortia seeking public funding.

Next to the need to reorient existing RTI policy instruments in ways outlined above, underpinning system transition also requires entirely new types of instruments. There is a need to enable collective socio-technical experimentation to explore successful transition trajectories. Joint learning spaces where users and providers of socio-technical solutions learn together need to be set up. Different formats ranging from focussed living-labs to large-scale experiments with innovative concepts in regions or cities need to be installed. Stakeholders need to be not only consulted, but actively involved in these innovation policy activities.

Finally, to achieve socio-technical system transition, innovation policy coordination efforts need to reach out far beyond the usual realms. Policy fields such as social policy and cultural policy need to be taken on board to tackle social innovation aspects of these system transitions.

4 Current Policy Strategies

In this chapter we will analyse some recent innovation policy documents from the European Commission and the OECD to examine to what extent policy already responds to some of the most important challenges from the emerging new innovation patterns we have identified within the INFU project. Important policy documents, studies, and strategies are the OECD innovation strategy launched in 2009 (OECD 2009), an OECD project about the “New Nature of Innovation” (OECD 2009), the Aho Report from 2006 (Aho 2006), the EU innovation strategy from 2006 (EC 2006), the Europe 2020 strategy, and more specifically the Innovation Union Flagship initiative (EC 2010).

The OECD activities probably most extensively and explicitly address the changing patterns of innovation and its implications for innovation policy. In 2009 the OECD launched a project entitled “New Nature of Innovation”. In the introduction, the OECD briefly summarises very well the essence of new innovation models: *”Co-creation, user involvement, environmental and societal challenges increasingly drive innovation today. Collaborative, global networking and new public private partnerships are becoming crucial elements in companies’ innovation processes”* (OECD, 2009). Another study focussing on policies for open innovation have been funded by the Era-Net Programme (de Jong et al., 2008) which is of interest as well.

Analysing the above mentioned documents reveals that in general i) open innovation, ii) a global innovation landscape, iii) intellectual property rights (IPR), and iv) grand challenges have gained the most attention within current policy debates related to new forms of innovation. We deal with these four issues in more detail next.

4.1 Open Innovation

If one term summarises the changing patterns of innovation most prominently, then it is probably the term “open innovation”. Chesbrough et al. (2006) describes the open innovation paradigm as follows: *“The open innovation paradigm treats research and development as an open system. Open innovation suggests that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well.”*

The OECD report *New Nature of Innovation* (OECD, 2009) describes nine innovation principles which deliver evidence of a new innovation behaviour. Thereby, principles 1 and 2 are considered as forms of open innovation focusing on user innovation:

"OECD Innovation Principle 1: Co-creating values with customers: In the new age of innovation, companies will co-create unique individual solutions with customers. The number of customers each company can co-create with might, in some cases, be virtually unlimited. Of course, there has always been a market for unique products, but this has tended to target a relatively small and exclusive customer group, and has been costly and time-consuming. Companies will need to use digital platforms to handle a lot of customers at the same time (in real time)."

Principle 2 entitled as 'Users' Involvement in Innovation Processes' claims that *"Companies have started involving users at an earlier stage in the innovation process. Companies are observing users to understand what problems they face and need solved, and are including them at the beginning of the innovation process. … … In order to obtain the often hidden knowledge that users possess, they might be involved either indirectly in the innovation process (for example through user observations and user experiments), or they might be directly involved in innovating for the company (for example as advanced users)."*

Based on the description of the changing innovation patterns, the *OECD Innovation Strategy* (OECD, 2010) defines a set of policy principles for innovation. Principle 1 – phrased as "empowering people to innovate" addresses the human factor within the innovation process. Thereby *"education and training systems should equip people with the foundations to learn and develop the broad range of skills needed for innovation in all of its forms, and with the flexibility to upgrade skills and adapt to changing market conditions. To foster an innovative workplace, ensure that employment policies facilitate efficient organisational change."* In addition, consumers should be enabled to be active participants in the innovation process. Like many other innovation policy strategies, the OECD calls for fostering the entrepreneurial culture *"by instilling the skills and attitudes needed for creative enterprise."*

These new innovation models also include new forms of innovation partnerships, new forms of collaboration which are change challenges for organizations. Within the OECD *New Nature of Innovation* Report (OECD, 2009), the Innovation Principle 4 'forming collaborative networks and partnerships' addresses the opening of innovation processes. It describes the forms of innovation partnerships which have become necessary and the emerging development needs of the involved partners. In this report it is argues companies' structure and organisation will have to change to realise new forms and methods of collaboration. In addition, employees will have to learn how to work in teams and management has to change their decision-making culture.

The European Commission has dealt with changing patterns of innovation within the "Innovation Union Strategy". According to the European Commission, companies innovate in various ways: *"While some conduct R&D and develop new technologies, many base their innovations on existing technologies or develop new business models or services driven by users and suppliers, or within clusters or networks. Policies must therefore be designed to support all forms of innovation, not only technological innovation. …As the problems grow more complex, and the costs of innovation increase, firms are increasingly being driven to collaborate. While they still carry out in-house development, this is often complemented with activities to identify, recognise and transfer ideas from external sources, such as universities or start-ups. They sometimes co-innovate with users and consumers in order to better satisfy their needs or create new routes to market. This trend is being fuelled by social networking and cloud, mobile and collaborative computing and is spreading across manufacturing and service sectors. It also has major implications for research, science, education and government itself."* This paragraph shows very clearly the awareness of the changing innovation patterns and implications for policy and is related to some of the findings from the INFU project.

With respect to the latter, the Commission highlights some implications for policy: "*These trends to open and collaborative innovation have major policy implications. While it is important to find the right balance between facilitating the diffusion of knowledge and providing sufficient incentives for innovation, the Commission believes that these trends will bring long-term economic and social benefits and should be supported. It is therefore more important than ever to deliver the so-called "fifth freedom", which is not only the free movement of researchers, but also the free movement of innovative ideas. Genuinely open innovation requires brokerage, intermediaries and networks in which all players can participate on an equal basis. Internationally competitive clusters play a vital role in bringing together – physically and virtually – large companies and SMEs, universities, research centres and communities of scientists and practitioners to exchange knowledge and ideas. Knowledge transfer between business and academia should be strengthened, and made to happen trans-nationally."* (EC 2010, 18).

The above mentioned recently funded EU project dealing with open innovation and public policy (de Jong et al., 2008; Chesbrough and Vanhaverbecke, 2011) has, for instance, recommended supporting collaboration, networking, and corporate entrepreneurship to foster open innovation. These elements are then further elaborated by defining 21 guidelines. These cover issues such as the promotion of user innovations, the provision of a high-quality IP system, enabling the creation of venture capital markets, fostering entrepreneurship education, the promotion of spin-offs, the support of open innovation processes in government procurement, but also the ongoing promotion for conducting R&D by companies via traditional financial incentives (e.g. tax credits).

4.2 Local Shifts of Innovation

In addition to and within the development of open innovation models, the geographical component is becoming more and more essential today. There has been a substantial shift in the global innovation landscape during the past two decades. Multi-nationals from developed economies are increasingly globalising their R&D activities and are developing an open innovation model to source innovations from outside the firm, including from emerging economies such as those in Asia. Additionally, some emerging economies which traditionally have played a secondary role in the global innovation landscape have now begun to catch up in developing their own innovative capabilities (Li et al., 2009).

However, making profit from globalised R&D activities seems to be no longer reserved to these internationally operating multi-nationals only. Globalisation in the 21st century is likely to be characterised by the increasing integration of a variety of innovative small and medium-sized players in international networks of production, movement of goods and flows of information and knowledge (Mathews, 2006).

Within the strategy report of the OECD *New Nature of Innovation* (OECD, 2009), the third innovation principle gives evidence of new innovation behaviour regarding the global innovation landscape, speaking about 'accessing and combining globally-dispersed knowledge'. The OECD argues that *"... the increasingly complex nature of innovation requires companies to tap knowledge, intangible resources and talent from across the world, collaborating across borders and continents, and becoming meta-national innovators with an integrated global "innovation chain" … While large companies have had the advantage of their multiple locations, smaller companies today are able to use digital technology and international communities to access certain kinds of knowledge from anywhere in the world, thus enabling them to exploit new knowledge in a way similar to much larger transnational (or multi-national) companies. Indeed, established transnational companies may be hindered by the traditional reliance on their home base for innovative products and business models."*

The OECD Innovation Strategy (OECD, 2010) addresses specifically with the fourth principle the global aspects of innovation and calls to "*improve international scientific and technological cooperation and technology transfer, including through the development of international mechanisms to finance innovation and share costs."* In addition, the OECD argues *"to spur innovation as a tool for development, strengthen the foundations for innovation in low income countries, including affordable access to modern technologies. Foster entrepreneurship throughout the economy, and enable entrepreneurs to experiment, invest and expand creative economic activities, particularly around agriculture."*

In the Innovation Union Flagship Initiative the Commission discusses the need for Europe to open its innovation processes globally: *"For Europe to be successful in this global push for excellence, it must further deepen its international scientific and technological cooperation."* However, the cohesion of the European Member States is an important topic too: *"Europe must avoid an "innovation divide" between the strongest innovating regions and the others."* (EC 2010). Here, again education is a major topic, Europe is aware that is has to attract and hold highly educated people. Moreover, scientific cooperation with third countries is an issue of common concern. Under topic no. 32 the Commission proposes: "t*he European Union should step up its cooperation on the roll-out of the global research infrastructures. By 2012, agreement should be reached with international partners on the development of research infrastructures, including ICT infrastructures, which owing to cost, complexity and/or interoperability requirements can only be developed on a global scale."* (EC 2010, 28)

4.3 Intellectual Property Rights

New forms of innovation partnerships raise the question of intellectual property rights (IPR) for the collaborating companies. OECD, European, and national strategy documents have put this issue prominently on their future agenda. The OECD again argues: *"As partners are involved in creating innovations together, questions of ownership will take on a new perspective. New agreements between companies, customers and users will have to be made in regard to intellectual property rights. …The trend towards more open innovation serves to put the IPR issue on the current political agenda"* (OECD, 2009).

In its Innovation Strategy the OECD (2010) also talks about the importance of governmental action in order to create and diffuse knowledge and reap its returns. The OECD stresses the necessity of IPR protection in order to encourage innovation, as well as the fact that too strong IPR may hinder appropriate follow-on research: *"Effective protection of IPRs is necessary to encourage innovation, investment and trade and must be combined with policies and mechanisms to facilitate access and transfer. …Weak protection of IPRs undermines incentives to invest in innovation, facilitates counterfeiting and piracy, reduces the potential for technology transfer and limits the formation of markets for knowledge. However, the protection of knowledge needs to be combined with policies and mechanisms that facilitate access and transfer. Excessively strong IPR may hamper the appropriate use of protected knowledge and discourage follow-on research and research in adjacent areas to the detriment of both competition and innovation…."*

The European Union has put this issue on its agenda as well. In the "Innovation Union" (EC 2010) the European Commission discusses the issue IPR as follows: *"A key issue is how to increase the flows of, and therefore benefits from, intellectual property rights (IPRs, including patents, design and copyrights). While the EU patent should dramatically reduce the cost of patenting in Europe, particularly for SMEs, the economic benefits will flow from the exploitation of IPRs in innovative products and services. This is critical in sectors such as semi-conductors and telecoms where companies need to bundle together many existing technologies and therefore require access rights to a range of IPRs. The markets for trading IPRs need to become less opaque and fragmented so that IPR buyers and sellers can find*

each other efficiently, financial investments are made in IPR assets, and transactions take place on fair terms. … The scope of intellectual property protection and the high quality of patents granted in Europe should be maintained to ensure that legal rights are clearly defined. ... although collaborative IPR arrangements (cross-licensing, patent pools, etc) generally have a positive impact, they also need to be examined to ensure they are not used anti-competitively."

Of interest in this context are also the findings from the EPO scenario exercise which were conducted in 2007. This report (EPO 2007) clearly reveals that it is very likely that the current patent system will change considerable in the future. The scenarios developed by an expert team vary considerable ranging from envisioning a future where large multinational still drive the patent system and build up powerful patent portfolio on the one hand to a future where we see a gradual erosion of the patent regime due to diminishing social trust and growing criticism of the patent system.

4.4 Grand Challenge Orientation

Recently, the idea that public support for research and innovation should address the grand challenges of our times and thereby contribute to the sustainable development of our society has received wide attention (e.g. OECD 2010, EC 2010). Accordingly, addressing "grand challenges" is an important element of the most recent policy strategies and initiatives at the European level and in particular in the Europe 2020 Flagship Initiative "Innovation Union". With the Innovation Union, EU funding programmes should be more closely linked to tackle societal challenges: climate change, energy security, demographic ageing or resource efficiency. The European Innovation Partnerships, for instance, particularly aim to address societal demands: *"Europe is faced with a number of major societal challenges such as an ageing population, the effects of climate change, and reduced availability of resources. Breakthroughs must be found in new treatments for life-threatening diseases, new solutions to improve the lives of elder people, ways to radically cut CO2 emissions and other sources of pollution in particular in cities, alternative sources of energy and substitutes for increasingly scarce raw materials, reducing and recycling waste and ending landfill, improvements in the quality of our water supply, smart transport with less congestion, healthy or high-quality food stuffs using sustainable production methods and technologies for fast and secure information handling and sharing, communication and interfacing"* (EC 2010, p 22). European innovation partnerships should tackle major societal challenges and increase the competitiveness of EU industry at the same time. Also, the EU Flagship Initiative prominently addresses the importance of fostering social innovations and social entrepreneurship.

The new Framework Programme "Horizon 2020" is explicitly oriented to focus research and innovation in specific areas related to the societal challenges, about 40% of the total budget (the other is for excellence and industrial leadership) will be allocated in the following areas: health, demographic change and wellbeing; food security, sustainable agriculture, marine and maritime research and the bio-economy; secure, clean and efficient energy; smart, green and integrated transport; climate action, resource efficiency and raw materials; inclusive, innovative and secure societies. In a similar way, several national strategies are being reoriented towards societal challenges[6]. Whereas the "normative turn" in innovation policy is being taken up by a number of countries in the form of demand-oriented RTI policy priorities, the requirement for new instruments arising from the need for system transitions are not yet being widely addressed.

[6] Eg. German High-tech Strategy, the Danish Research 2020 process.

5 Summary and Conclusions

The emergence of new innovation patterns such as open innovation, user innovation, design innovation and community innovations involving new actors, different roles and new modes of interaction implies re-configurations in European innovation systems with diverse implications for the European economy, society and policy in the long run.

In order for research, innovation and other policies to be prepared for challenges arising from these changes and to be able to benefit from them, a more solid understanding of possible innovation futures and their implications for society is needed. Therefore, the INFU research project explored how the process of the creation, development and introduction of innovations is changing and focused on the process of 'innovating innovation'.

Based on the scanning of signals regarding the change of innovation patterns, and reviewing the recent academic literature dealing with new forms of innovation, the INFU research team has generated a number of innovation visions which have been discussed by many experts through a survey, by conducting interviews and organising workshops.

The innovation patterns discussed seem to be at a critical point where the possible acceptance of societal needs to be addressed and a deliberate, active steering of the development could lead to many benefits, such as systemic improvements. On the other hand, an uncontrolled development, driven by external forces, combined with a rejection of parts of the society may lead to the exclusion of specific groups of society from the innovation process. In this case new innovation patterns will bring about short-term benefits for specific groups, but at the same time negative side effects for the system as a whole. We are thus facing a unique window of opportunity for actively modulating changing innovation landscapes in a way that allows us to reap the potential benefits and avert many of the threats. In this context, it is especially worth noting that for all visions the risk of societal divide was explicitly mentioned.

In many cases positive implications heavily depend on the acceptance or even active support of society or at least of specific parts of society. Future innovation landscapes with a number of positive implications for society, the economy and the environment alike, such as the vision of the "open innovation city", require the explicit support and involvement of different groups of society. The same holds for automatised innovation. This pattern may well emerge without any deliberate participation.

Education and innovation are closely tight together. Education policy will remain an important domain in the future. Future education concepts will have to recognise the changing nature of innovation in order to enable young people to contribute to and benefit from the new innovation patterns. At the same time, change in innovation patterns will be driven by new forms of learning and identity formation.

The analysis of the various innovation visions allowed us to synthesise specific key characteristics describing the innovation patterns. These trends are: (1) Mediation and coordination, (2) Participation, (3) Motivation, (4) Automatisation, (5) Infrastructures, (6) Perception of creativity, (7) Spatial shifts, and (8) Systemic sustainability Innovation.

Based on an assessment (of opportunities and risk) along these eight dimensions of change, we discussed implications for policy and indicated new directions for research and innovation policy. A brief analysis of current policy strategies at the European level and the OCED has shown that collaboration, globalisation and localisation, IPRs and addressing societal needs has attracted much attention by policy-makers in the last years.

From the findings of our INFU project we can summarise main challenges for policy-making (see box). They partly go hand in hand with the above mentioned EU and OECD policy documents, and therefore underpin and extend their guiding principles and policy conclusions. However, we also offer lessons for policy which go beyond these topics. In particular, the necessity to provide new forms of infrastructure, the increasing role of software with its significant positive, but also negative potentials, and the need to use new indicators (considering the importance of value-driven innovations) reveal new directions for policy-making.

Moreover, in order to ensure that progress towards grand challenges is made, in many fields real transformation at a system level is required which goes beyond isolated development by individual actors. This means, for example, that social and ecological criteria are considered during the entire innovation process and coordination among many actors from the economy, science, policy and civil society is required, exceeding superficial consultation. In many cases a system integrator has to be established.

The conclusions for policy have been discussed mainly at the European level. New innovation patterns, however, also require policy reactions at the national and regional level but also on a global scale.

The INFU Policy Challenges at a glance

1. **Establish rules for new forms of coordination and mediation.** A new regulatory framework for the new types of distributed innovation needs to be put in place, e.g. IPR and for the distribution of profits between organisations and individuals. In addition, new strategies such as public domain, copyleft and creative commons enable new forms of innovation which at the same time do not crowd out motivation.

2. **Enable participation.** Build up competencies for a participatory society, develop tailored procedures for different types of interaction of actors from academia, industry, education and civil society (quadruple helix). Define adequate levels and scales of participation for each phase of decision-making. This implies a change in the role of policy-makers towards mediators. In addition, when individuals (e.g. citizens, users, laymen) or groups of individuals organise themselves, new target groups come into focus for RTI policy.

3. **Policy for social enterprises.** Raise awareness of the relevance of social innovation, understand the requirements of social innovation and develop adequate support mechanisms.

4. **New indicators for innovation.** Distinguish the effects of innovation on society and effects on growth. Measure quality (e.g. well-being and quality of life) instead of quantity to define the success of innovation policy.

5. **Value-driven innovation.** Motivate innovation around grand challenges. Support innovation for its outcome, not for its own sake. Apply holistic measures for the global benefits of innovation. Explore the use of modelling and simulation of innovation effects. In addition, the direction of development of innovation should be guided by demand-side innovation policies, such as public procurement and increased labelling and giving meaning to products and innovations.

6. **Smart 'GLocalisation'.** Foster localisation without localism. Unlock regional lead markets for global solutions. Support regions in the tailored transfer of their joint solutions. Support dialogue among regions and cities. Raise awareness for and build

competence for low-tech solutions for global needs. At the same time, innovation policy should reduce barriers for European companies to expand their R&D activities in third countries and help to deepen scientific and technological cooperation and transfer of technology.

7. **Enable everyday creativity.** Foster creativity and playful experimentation from early on. Develop the skills for prospering in today's complex society instead of formal qualifications only. Avoid the creativity divide. Underpin "active jobs" and creative working culture.

8. **Enable transformative system innovation.** Foster system-oriented research, development and innovation projects e.g. through involving mandatory system integrators. Integrate technical and social science and humanities research and innovation and weight them equally. Involve stakeholders and enable large scale socio-technical experimentation.

9. **Policy coordination.** Coordinate policies across DGs (European level) and Ministries (national level) concerned with innovation, but also towards different policy realms such as education, health, social and cultural policy, in order to reach out to social innovation and achieve socio-technical innovation.

10. **Innovation link chains.** Focus on links in the innovation chains leading from research to innovation, including societal embedding instead of at looking at R&D in isolation. Assess projects by their system fit and enhance the capacity to innovate.

11. **Software.** Software will play an ever-growing role in innovation. More and more innovation steps may become automatised, e.g. by using web crawlers to identify ideas, but also by using simulation algorithms to generate ideas and to assess market potentials. Policy should be very aware of the risks of an increased automatisation of innovation and possible unintended long-term effects on creativity. Thus, they will be asked to seek a balance between enabling faster and efficient innovation processes based on software algorithms on the one hand, and to ensure data security and transparency, on the other.

12. **Innovation Infrastructure.** Install infrastructure such as fab-labs and innovation camps with a low entry barrier to enable collective innovation and smart bricolage for all actors and in particular civil society. Make use of the possibilities of modern ICTs and methods to enable participation.

6 References

Aho (2006): Creating an Innovative Europe Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit" January 2006, http://europa.eu.int/invest-in-research.

Arnkil, R., Järvensivu, A., Koski, P., Piirainen, T. (2010): Exploring Quadruple Helix. Outlining user-oriented innovation models, Final Report on Quadruple Helix Research for the CLIQ project University of Tampere, Institute for Social Research, Työraportteja 85/2010 Working Papers.

Chesbrough, H., Vanhaverbeke, W., West, J. (2006): Open Innovation: Researching a New Paradigm, Oxford.

Chesbrough, H., Vanhaverbecke, W. (2011): Open Innovation and Public Policy in Europe, Research Report, ESADE Business School & the Science I Business Innovation Board AISBL.

Christensen, T. (2011): Business Research, Development and Innovation in Denmark – policies and effects, Danish Agency for Science, Technology and Innovation (DASTI), Danish Ministry of Science, Innovation and Higher Education, Copenhagen.

De Jong, J.P., Vanhaverbeke, W., Kalvet, T., Chesbrough, H. (2008): Policies for Open. Innovation: Theory, Framework and Cases, Research project funded by VISION Era-Net, Helsinki.

EC (2006): Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Putting knowledge into practice: A broad-based innovation strategy for the EU. COM (2006) 502 final.

EPO (2007): Scenarios for the Future. How might IP regimes evolve by 2025? What global legitimacy might such regimes have? European Patent Office.

EC (2005): Common Actions for Growth and Employment: The Community Lisbon Programme - COM(2005) 330, Brussels.

EC (2006): Putting knowledge into practice: A broad-based innovation strategy for the EU - COM(2006) 502 final, Brussels.

EC (2010): Europe 2020 Flagship Initiative - Innovation Union - COM(2010) 546 final, Brussels.

Etzkowitz, H., Leydesdorff, L. (2000): The dynamics of innovation: from National Systems and ‘‘Mode 2’’ to a Triple Helix of university–industry–government relations, Research Policy, 29, 109–123.

Henkel, J., von Hippel, E. (2005): Welfare implications of user innovation, Journal of Technology Transfer, 30, 1/2, 73–87.

Li, J., Kozhikode, R.K. (2009): Developing new innovation models: Shifts in the innovation landscapes in emerging economies and implications for global R&D management, Journal of International Management, 15, 328–339.

Mathews, J. (2006): Dragon multinationals: new players in 21st century globalization, Asia Pacific Journal of Management 23, 139–141.

OECD (2009): New Nature of Innovation, OECD, Paris.

OECD (2010): OECD Innovation Strategy, OECD, Paris.

WIPO (2011): 2011 World Intellectual Property Report. The Changing Face of Innovation, WIPO Economics & Statistics Series, World Intellectual Property Organization.

7 Appendix

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