Deliverable Report

Grant Agreement number: 266538

Project acronym: ECO-INNOVERA

Project title: ERA-Net on eco-innovation – Boosting eco-innovation through joint cooperation in research and dissemination

Funding Scheme: Coordination and support actions (Coordinating)

Date of latest version of Annex I against which the assessment will be made: 16th September, 2010

Deliverable Number: Draft report D1.2

Deliverable Title: D1.2 Research and Innovation Strategy – Interim Strategy

Name, title and organisation of the scientific representative of the project's coordinator:

MSc Evelyn Echeverría
Project Management Juelich
Division Environment (UMW)
Forschungszentrum Juelich GmbH
Zimmerstraße 26-27
10969 Berlin
Germany
Tel: +49 (0)30 20199-3134
E-mail: e.echeverria@fz-juelich.de

Description of the Deliverable:
Task 1.2 has the objective to develop and maintain a research and innovation (R&I) agenda for ECO-INNOVERA. The R&I strategy should be regarded as living document, bringing together the expertise and knowledge of the network, analysed in the light of the most recent policy and research developments at different points of time. The main deliverable of this task will be a series of strategy documents, each presenting a progressively broader and more detailed analysis.

- Position paper (Mn 9)
- Interim strategy (Mn 23) provided herewith
- Full strategy document (Mn 45)

The position paper had a horizon of 1-2 years and synthesised the outputs from the workshops and meetings conducted under tasks 1.1, 2.1 and 3.1 to describe the landscape of eco-innovation activities and identify shared high-level priorities and interests of project partners. The interim strategy will have a horizon of 2-4 years and will make use of the position paper as a basis for engagement and discussions with a range of stakeholders. The remit of the interim strategy document will be to broaden and deepen the analysis provided in the position paper, and to identify research needs and interventions to boost eco-innovation in European industry, and in particular to improve participation of SMEs. It will serve to inform the selection of topics for the second joint call, linking to task 3.3.

Contents

Introduction

ECO-INNOVERA is a European network (ERA-Net) funded by the European Commission with the objective to promote the research, development and implementation of eco-innovation. The network comprises 24 partners, with a diverse membership taken from policymakers, research funders and innovation agencies.

In the Description of Work (DoW) submitted by the network to the Commission, task 1.2 details a number of activities to be completed in order to develop a Research and Innovation strategy for ECO-INNOVERA. At this level, the ERA-Net functions as a project, intended to form a solid foundation for the better co-ordination of eco-innovation in Europe.

The ambition of the consortium partners, however, goes beyond the project described in the DoW. We believe there is a unique opportunity to build a larger programme of activities, based on the intersection of interests of 24 partners. The R&I strategy seeks to identify and prioritise value-adding activities for the partners, individually and jointly or at European level. It is the start of the process by which the ERA-Net moves beyond a project into pro-active network. Our ultimate objective (this is described in task 1.5 of the DoW) is that the network becomes self-sustaining.

The purpose of this document is to identify discrete activities that the network partners can take forward, either directly or through influencing others to act, to accelerate and increase the impact of eco-innovation national scales and at a European scale.

Previous work under this task has been described in the Position Paper. In summary, we have identified six topics for further development over the lifetime of the network:

1. Developing a common understanding of eco-innovation
2. A better understanding of national/regional programmes, leading to a research landscape for eco-innovation in Europe
3. Metrics
4. Value chains and business models
5. Systems thinking applied to different sectors
6. Structuring eco-innovation: sectoral roadmaps

This document addresses aspects of topics 1 and 2 (under the heading Definitions and Frameworks); topic 3 (Metrics) and topic 5 (System innovation).

Definitions and Frameworks

Several authors have proposed definitions for eco-innovation[1] but we refer the one introduced by the Eco-innovation Observatory (EIO):

> *"Eco-innovation is the introduction of any new or significantly improved product (good or service) process, organizational change or marketing solution that reduces the use of natural resources (including materials, energy , water and land) and decreases the release of harmful resources over the whole life-cycle". (EIO 2010)*

The definition is broad, and by implication so is the remit of ECO-INNOVERA, although the fields of transport and energy generation are formally excluded from the project. Many actors – networks, projects, industry bodies etc – are active across this space. To provide focus, minimize the risk of duplication of effort and identify opportunities for collaboration, framework(s) which provide the facility to map and compare specific activities within this broad definition would be helpful. The following paragraphs outline some of the different ways that eco-innovation has been classified.

The sources of eco-innovation are diverse and may not require the development of new technologies. Eco-innovation can equally be the assembly or integration of a set of existing technologies employed in disparate sectors to meet a defined environmental challenge. For example, the development of carbon capture technologies draws on a set of commercially available technologies from the oil, chemical and power generation industries. (OECD 2011).

The EIO distinguishes between eco-innovation and eco-industries. Eco industries form sector(s) originating in environmental technologies but also including "green products and technologies" and "green energy" , that is serving markets for environmental goods and services. Eco-innovations are considered to be solutions that are novel to both a company and to the market, but may not be driven by explicit requirement to reduce environmental impact (typically the driver is reducing costs of materials/energy in order to increase competitiveness). (EIO 2010)

The terms eco-efficiency and eco-effectiveness are also sometimes used. In general terms, eco-efficiency approaches tend to work within the boundaries of an existing industrial system, and can be viewed as "doing more with less". Eco-effectiveness approaches imply change at a system level, and are associated with highly circular industrial systems based on a "waste is food" approach as introduced in the influential publication "Cradle to Cradle", referring to "industrial systems that emulate the healthy abundance of nature".

Literature approaches based on the OECD Oslo Manual definition focus on an analysis of eco-innovation in terms of its ***targets*** (the main focus of the eco-innovation), its ***mechanisms*** (how change is exerted on those targets) and its ***impacts*** (the effects of those changes on environmental conditions). A useful typology, proposed in OECD2009 and combining approaches of other authors, provides sub-structure to the targets and mechanisms of eco-innovation, and broadly distinguishes measures as either being primarily technological change or primarily non-technological change.

---

[1] For a summary of some of these definitions, see Cariilo-Hermosilla *et al*, pg 7

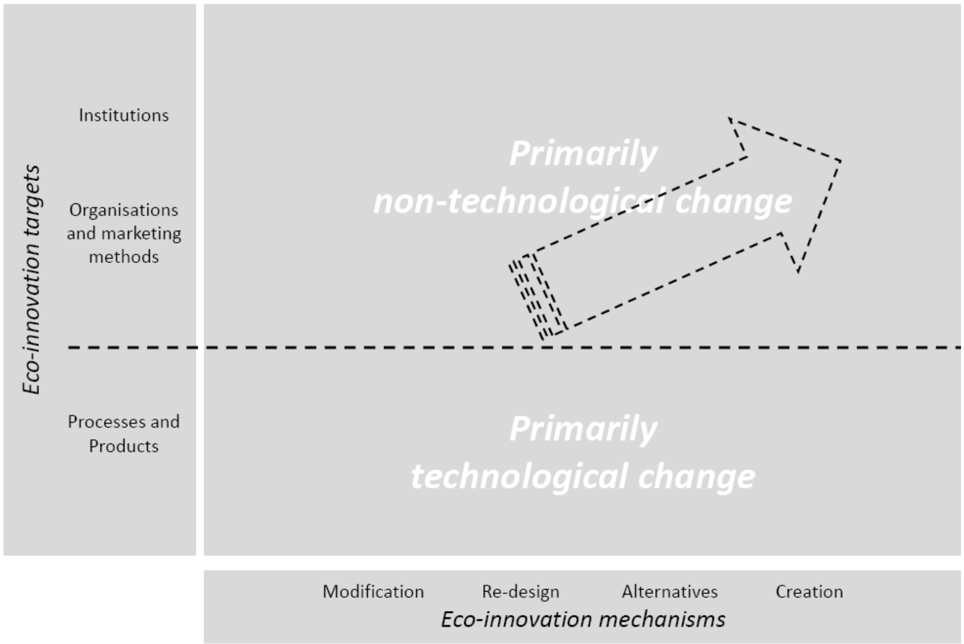


Figure 1: A typology for eco-innovation (OECD, 2009)

The direction of EU environmental policy over the last 30 years broadly correlates to the direction of the arrow on this diagram, from measures focused primarily focused on pollution control/end-of-pipe technologies, through to cleaner manufacturing / full life cycle approaches through to measures intended to change patterns in consumption and production.

It is broadly recognized that technological innovation alone is not sufficient to put the European economy onto a sustainable path; to meet the magnitude of this challenge will require innovations which are more systemic in nature, also involving social changes and measures to gain public acceptance. These more systemic types of eco-innovation will tend a) to be more complex, having several components on the above matrix and b) have significant components above the dotted line demarking primarily technological and non-technological change.

Previous work (described in our position paper) has confirmed that no single framework would be sufficient to present the range of eco-innovation policies and activities to a broad audience base. Not only is the range of activities that can be described as eco-innovation vast, but also there are potentially multiple audiences and users of any given framework. In these circumstances, trying to develop a single, universal framework would be confusing and could even be counterproductive.

Currently, ECO-INNOVERA makes use of two frameworks with distinctive objectives and application which will be applied and evaluated as appropriate to the needs of the project:

- Eco-innovation landscape: a pragmatic “bottom-up” approach which maps known activities against quasi “sectors” including resources, agri-food, manufacturing, construction and services.   Originally developed as a spreadsheet tool for internal use, we are evaluating the use of visualization software to increase its utility and application.
- CML framework: an open framework designed primarily for use by policymakers. Its current status is described later in this document.

In conjunction with these frameworks, our work on metrics provides an approach for qualification and quantification of progress in eco-innovation.

Eco-innovation landscape

A visualization tool, utilizing the Sharpcloud software platform[2], is being developed and evaluated with the objective to provide a means to map and compare networks, projects (at an EU and individual country level) and to present case studies of eco-innovation in practice. The dimensions of the platform and the approach used mean that that every activity must first be placed into one of 8 categories as follows:

1. Resources (includes primary resources such as minerals, metals, biomass; water, land, air; also secondary resources such as recycled materials)
2. Agriculture & Food (includes fisheries and forestry)
3. Construction & Infrastructure
4. Manufacturing & ICT (includes advanced materials, nanotechnology, electronics)
5. Health (human, animal, plant)
6. Services (includes tourism, creative industries such as (eco)-design)
7. Cross-cutting (where multiple categories apply or for cross-cutting programmes such as fundamenta, social l or environmental sciences)
8. Energy & Transport[3] (includes energy generation, energy efficiency, road, rail, aviation, marine; integrated transport/mobility approaches)

In addition to these categories, data may be included as required to represent the following characteristics:

Size and scale of the activity (for example micro / meso / macro level for a policy intervention, or local/regional / national / transnational/ European/International for a project or network)

Mechanism of the ecoinnovation (Processes & products/ Organizational and marketing methods/ institution, as used in the OECD typology in Figure 1)

Target of the ecoinnovation (modification/re-design/alteration/creation, as used in the OECD typology in Figure 1).

Development status (Fundamental research/ applied research/ demonstration/ market introduction/ market replication)

These characteristics can be manipulated, using appropriate tags or filters to simplify the visible content, to present the information in a number of view formats.

In principle, this landscape could provide a repository of expert information for communication and awareness raising in the wider society, and to help mobilize the eco-innovation community and promote dialogue on developments and good practices in eco-innovation. In particular it could serve to connect actors and platforms at the European level (e.g. ETPs and EIPs) and thus promote a common, coherent and coordinated approach throughout economic sectors as well as cross-sectoral.

---

[2] www.sharpcloud.com

[3] Formally these sectors are outside the scope of ECO-INNOVERA but they are included here for completeness of the analysis.

CML Framework

Support has been provided to ECO-INNOVERA in developing a policy-oriented framework for eco-innovation by the Institute for Environmental Sciences (CML) at Leiden University, The Netherlands. This work has been financed through a contract with the Netherlands' Ministry of Infrastructure and the Environment, Sustainability Department.

A brief description of the approach and how it may be applied is provided here; for a fuller treatment see the paper "Developing and Evaluating Eco-Innovation Programmes and Projects: A Framework-based perspective", which can be downloaded from http://www.eco-innovera.eu/publications.

The objective of the CML framework is to provide for an analytical understanding of eco-innovation and the factors of influence at the micro, meso and macro levels. It allows for an individual or benchmark assessment of policies, programmes and projects and will help identify suggestions for optimalisation of the policy, programme or project in question.

The CML approach considers eco-innovation to be defined in terms of either: performance, a process leading to improved performance, or in terms of indicators (as proxies for performance where this is difficult to measure directly). In some cases, a simple win-win in terms of economic and environmental performance is sufficient, but it is pointed out that higher productivity can lead to economic growth to the extent that the environmental benefits in absolute terms are reduced or even negated (known as the Rebound Effect).

While a simple win:win can be satisfactory at a micro-economic level (for example from the perspective of an individual business), from a policymaker's perspective then, a more stringent definition of eco-innovation would be that it supports absolute decoupling of economic growth from environmental impact at a meso (i.e. value-chain or material chain) or macro level. While this refined definition is readily understandable at a conceptual level, evidencing this in detail is not straightforward, particularly if the eco-innovation is more complex than replacement of one process or product for another.

This complexity presents the policymaker with a problem. Fitting all options for policies and their instrumentation to all relevant mechanisms in society, with an ultimate view on macro level decoupling is too difficult and laborious a task. At the same time, there is a need to design and evaluate policies systematically with some consideration of the indirect effects that may ensue if that policy is to be well-designed to meet longer-term objectives.

The taxonomy used in the CML framework (Figure 2) bears some resemblance to OECD at a high-level but differs significantly in the sub-structure. Three levels of structure are envisaged in the framework: **Instruments** for eco-innovation use a number of **mechanisms** leading to the desired **goals** in terms of improved economic, environmental and/or social performance.

Key features of the CML framework are that there are 1) an explicit set of documented societal goals, determining the way performance is to be measured and 2) an explicit treatment of the core mechanisms influenced directly and how they lead to the performance goals also indirectly through other mechanisms involved. Within the sub-structure of mechanisms in this framework, a distinction is made between mechanisms that operate at a technology, economy and society level. This recognizes the complex nature of multiple interactions necessary to effect high-impact paradigm change, analogous to system eco-innovation as described elsewhere in this document.

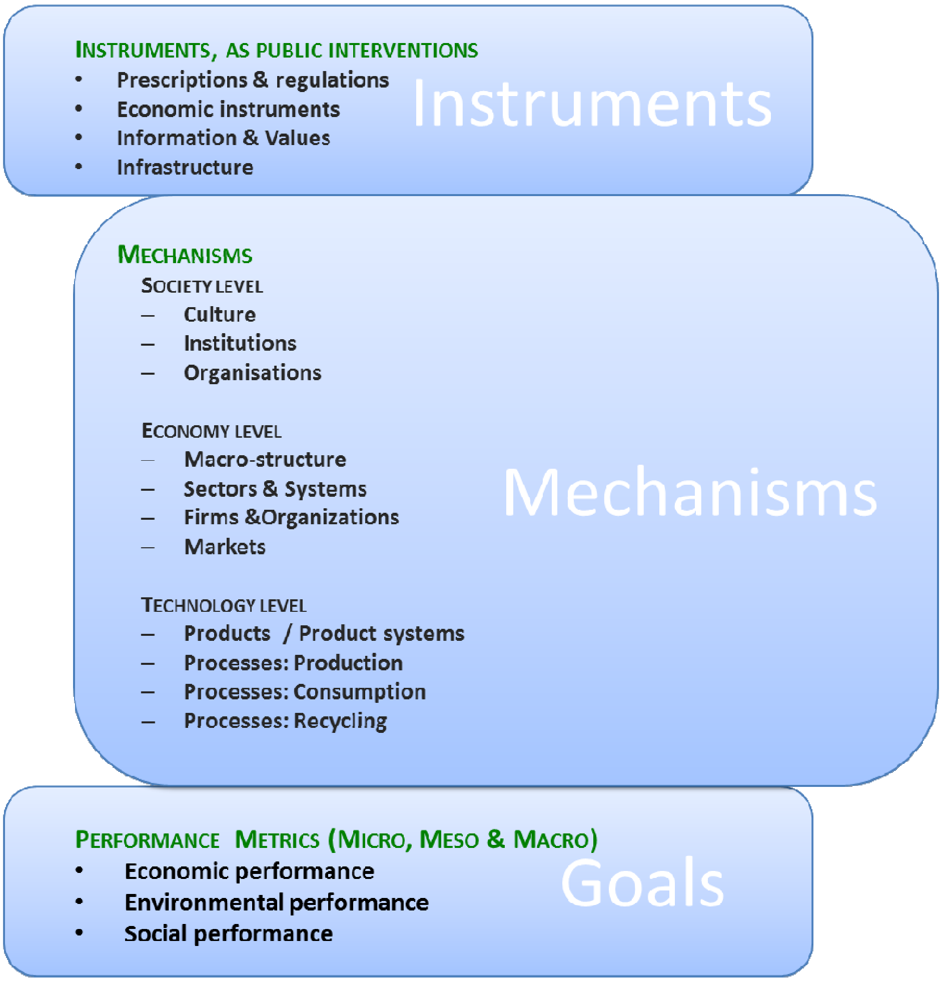


Figure 2: Eco-innovation framework, as proposed by CML

The CML framework is open, in that it does not specify the goals to be reached. It is not prescriptive in terms of the mechanisms that should be employed in a specific case, although it does describe in general terms the range of options that might be considered.

To date, the CML framework has been tested by evaluating projects and programmes for eco-innovation. The framework could also be used to help policy makers mover from supporting individual sector/material/product/process innovations to a more systemic approach which is necessary if sustainability objectives are to be met. For example, this could be from product to product system; from new technique to system change; from product to service; from individual economic actors to chains of producers, consumers and organizations; and from technical innovation to technology innovations and to pure organizational innovation.

Finally, the CML framework could be used by research funders to reduce the (currently high) uncertainty in the evaluation of the performance of eco-innovation projects and programmes. This could be achieved by improving the set-up of the empirical analysis, as in linking micro actions to macro level consequences, and improving normative analysis, as in practically specifying trade-offs between different goals. Thus, the CML framework may help policy makers and programme owners to achieve certain set goals, and may help project developers to address all relevant aspects in an eco-innovation project.

Metrics

Work on metrics has formed the focus of task 2.4 of the ECO-INNOVERA project, under the leadership of IWT, Belgium[4]. A synopsis of relevant information from the latest report on this activity is presented here and their impact considered in the discussion section of this document.

Much of the work in this task has focused on the evaluation of (a range of) metrics that might be applied to eco-innovation programmes in general and specifically to the second ECO-INNOVERA call. The work has included a consideration the extent to which quantitative versus qualitative metrics are employed, and whether it is feasible to include social criteria for eco-innovation projects. The work included contributions from an expert workshop "Learning about quantitative tools or methodologies for evaluation eco-innovation projects", the presentations from which are available on the ECO-INNOVERA website.

Relevant points from this analysis include:

- Most innovation programmes involved in ECO-INNOVERA use qualitative criteria for the evaluating environmental impacts of projects, and so comparing across programmes (even across projects) is far from easy.
- There is a wide range (over 80) of Life Cycle (Inventory) Assessment or LC(I)A-like tools available, and a smaller number of recognized LCA methods. Among the latter group, ReCiPe[5] seems to be widely known and forms the basis of a popular eco-design tool.
- Monetary valuation in LCA or the quantification of external costs is possible but there are concerns over its application to ecosystems and depletion, owing to uncertainties related to concepts, quantification and monetary valuation.
- There are doubts over the applicability of LCA tools when applied to system innovation or step change innovations. Here it is likely that qualitative criteria will need to be applied, but there is scope for more quantitative approaches when a reference situation can be defined.
- Some counter-evidence was cited, that there was no empirical evidence that radical system innovations can contribute to significant environmental impacts compared with incremental innovations (Renning, 2010). The success of a technology is not predictable; a series of incremental innovations effectively diffused and replicated at scale may be more effective than a radical innovation that has limited success.
- The "Sustainable technology development" framework developed by IWT provides an example of how to motivate (and ultimately quantify the benefits of) life cycle thinking in an innovation project. This makes use of a reference sitatuion on the market, an assessment of the environmental performance of the innovation and its potential for exploitation.

The work on metrics conducted within the project not only provides project for ex-ante assessment of eco-innovation, but in principle could help bridge the gap between understanding individual incremental innovation and system innovation, provided the system boundaries and reference are well defined.

---

[4] agentschap voor Innovatie door Wetenschap en Technologie

[5] http://lcia-recipe.net

System Innovation

The case for system (eco)innovation

In this section we consider the rationale for a public sector intervention to support system eco(innovation) and the case for ECO-INNOVERA to participate in this.

It should first be recognized that many European companies are already implementing eco-innovation: the EIO cites a recent report in which 27% of innovating companies in the EU increased their material efficiency as the result of implemented changes. (EIO 2011). The 2011 Eurobarometer survey on eco-innovation reported that around 45% of companies had introduced a product, process or organization eco-innovation in the last two years. A small proportion of these (4%) reported that this change led to a more than 40% reduction in material use per unit output that is at the level approaching a Factor 2 eco-innovation. For the vast majority of companies, the improvements were more modest and incremental.

These eco-innovations are in some cases supported by various national, regional or other innovation support schemes, or may an internal response to drivers such as increasing energy or material costs. Several funding agencies have evaluated the effectiveness of support schemes and there is good evidence that support for incremental/ low-cost eco-innovation measures provides a good return on investment and are particularly effective in terms of supporting SMEs. (EIO 2011 and references cited therein)

From a micro perspective, it is important to understand the effectiveness of these programmes and how their impact may be increased. From a macro perspective, it is necessary to understand the cumulative impact of these programmes and the extent to which they support European policy objectives. The EIO notes that there is an "eco-innovation gap" in terms of both the scale of eco-innovation activities (there being large differences between countries, sectors and companies) and the scope of eco-innovation changes, with a tendency towards more incremental rather than radical change.

Europe, as an industrialized economy, is an intensive user of resources with consumption averaging around 14.5 tonnes per person. While have been relative improvements in material efficiency - material consumption increased by 7.8% in absolute terms between 2000-2007 at the same time as the economy grew by 35% - as yet the efficiency gains have not been sufficient to bring about a reduction in the overall use of natural resources. European policy – as articulated in the European Commission's Roadmap to a Resource Efficient Europe and the EcoInnovaton Action Plan – requires or implies an absolute decoupling in the use of natural resources. The current trajectory for eco-innovation improvements – even if the small proportion of companies achieving near Factor 2 improvements could be massively expanded – cannot achieve this objective.

The EIO has identified the "Eco-Innovation Challenge" which has two components. The first component is to further improve the resource efficiency performance of the EU by promoting eco-innovation and ensuring that the benefits of new solutions are widely disseminated. The second, and more demanding component is to ensure that the efficiency gains are not offset by growth in the total consumption of natural resources. The EIO estimates that targets for absolute reduction of material consumption ranging from Factor 2 (i.e. 50%) to Factor 5 (80%) will be necessary by 2050 if absolute decoupling of economic growth from material consumption is to be achieved and European policy objectives are to be met. (EIO, 2012).

The types of eco-innovation necessary to achieve such a transformation in resource use extend beyond the deployment of technological solutions alone to approaches which are more systemic in nature. Bleischwitz et al (2009) considered system innovation to be one of three distinct categories of eco-innovation. By this analysis, system innovations are concerned with technological systems, disruptive technologies and system changes and associated with approaches such as life-cycle analysis, cradle to cradle, material flow analysis, closed loop, factor 4 or 10 amongst others.

System innovations, according to Geels,[6] can be seen as “a change from one socio-technical system to another.” The functions of a society in this model are met by ‘socio-technical systems’ – “a cluster of elements, including technology, regulation, user practices and markets, cultural meaning, infrastructure, maintenance networks, and supply networks.” Encouraging system innovation can be seen as structuring these transitions - in the image below this is the coalescence of smaller arrows into the larger arrows. The result is that the individual elements become aligned and stabilise into a new design, creating the momentum for a system shift.

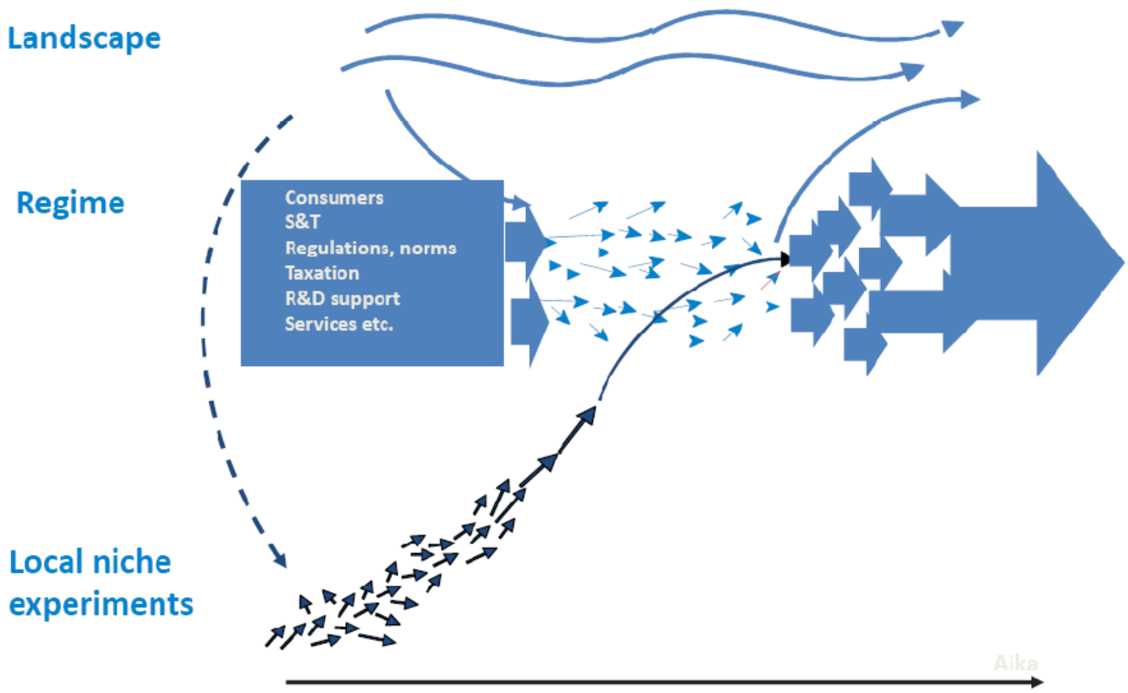


Figure 3: System level changes and innovations. Source: Tekes, after Geels (2011)

The implication is that the correct mix of policy interventions and research support - tailored to intervene at the tipping points and levers of a given system – has the potential to achieve a ***deeper*** level of innovation, ***faster*** than through a traditional, non-system approach. Furthermore, if the system is correctly defined and its potential interactions with other systems are well understood, the possibility of unintended consequences is reduced.

[6] See Appendix 1 for a perspective on research approaches to system innovation.

The overall objective of ECO-INNOVERA is to support innovation to reduce environmental impacts/resource use at a European level. Systems thinking (and by extension support for system innovation) is one method to do this and one which potentially offers the prospect of encouraging high-impact change at the level of both environment and economy.

ECO-INNOVERA has strengths that place it in a unique position to support system (eco)innovation. The network members have a diverse set of experiences, both in terms of programmeming (research funding, innovation support, policymaking) and national /regional context. As a cross-cutting network with a remit to support eco-innovation, it can reasonably expect to have influence in shaping EU-wide policy and has the opportunity to occupy a distinctive space of high policy significance. At a national/regional level, network members provide links to national funding opportunities which can translate into practice.

System Innovation workshop

Having identified a need to support system (eco)innovation, further work was necessary to identify specific measures the network could take forward that would add-value while being commensurate with the available resource. In August 2012 a workshop was held, facilitated by Forum for the Future (F4F) to identify some practical the network might take forward to support system innovation in practice. The workshop participants were drawn from ECO-INNOVERA, the EIO, and EcoPol[7].

The workshop was structured around the following objectives:

- To develop a shared sense of vision and purpose for a system innovation strategy and agree a working definition of system innovation
- To develop a broad set of strategic options for the network on system innovation
- To identify how ECO-INNOVERA can accelerate system level eco-innovation

Thinking about systems innovation means embracing and understanding complexity. This means it is difficult, perhaps even counter-productive, to attempt to provide an inflexible or universal definition of system innovation. Instead, the workshop group sought to identify some of the characteristics by which system (eco)innovation can be identified, and which might provide some insight on the levers that can help bring about a system shift.

The key characteristics of system (eco)innovation were identified by the workshop participants as being:

1. Interdisciplinary, multi-faceted - combining behaviour, technology, policy and economy;
2. Radical, transformative – creates significant change, using new approaches and applications
3. Collaborative - cross sector, involving different players, new entrants and new types of partnerships;
4. Including whole value chains
5. Designed to work towards a shared eco or sustainability goal

[7] EcoPol (http://www.ecopol-project.eu/) is an EU-funded project with the objective to accelerate the implementation of eco-innovation policies across Europe

A series of case studies were discussed – the Sustainable Shipping Initiative[8], the UK's Future Cities programme[9] and a leading company's approach to system innovation (closed loop models of production). Working in groups, the workshop identified over 20 potential practical measures that ECO-INNOVERA might take forward to support system innovation.

Based on a discussion of what the networks impact could be in 2016, the measures were consolidated and prioritized to give 2 activities supporting an overall network objective.

Objective: By 2016, Eco-Innovera is seen as a key resource on system (eco)innovation in practice and for policy support, providing access to the information, tools and techniques necessary to make this happen.

Supporting Activities

1. To build a community of practitioners which effectively is a strategic network of: thought leaders for system change, facilitators to help others use the tools, cascade mentoring.
2. To promote ways to make funding more widely available for delivery of System Innovation projects – pilot projects, new funds, funding criteria etc.

Figure 4: Potential ECO-INNOVERA objective and supporting options for system innovation

The potential scope of the activities is described in greater detail in the following pages.

[8] http://www.forumforthefuture.org/project/sustainable-shipping-initiative/overview

[9] https://connect.innovateuk.org/web/future-cities

Activity 1: Community of practitioners

System innovation is an emerging field which is attracting great interest from a range of different audiences – government, business, researchers and others. With this field being at such an early stage of development it is expected that experienced practitioners – "champions" of system (eco)innovation – will be motivated to share knowledge and encourage others. Currently there are few, if any, formal networks supporting system innovation and so there is an opportunity for ECO-INNOVERA to support an embryonic community of practitioners, starting at the European level but with the aspiration to be global in scope.

There would be multiple opportunities in this community for learning, cross-fertilisation of ideas or more active forms of collaboration. We see a role for ECO-INNOVERA to support this community by:

1) Sharing understanding
   a. Among the broader consortium, to achieve a common understanding, and broader ownership of this topic as a network strength, and to inform discussions at a partner level of what system innovation might mean in a national/regional context.
   b. With key partner networks and projects. This process has already started through the involvement of EcoPol and the Eco-innovation Observatory but could be extended to include key partner ERANets and organization and programme owners at the European Commission). Other partner networks could have particular sectoral expertise or provide access to SMEs.

   The content to support this shared understanding could be a combination of practical examples and inspirational speakers who are either recognised advocates of system innovation and/or have had experience of system innovation in practice.

2) Connecting active practitioners:
   a. This could be a high-level forum or a series of working groups of individuals are comfortable working with uncertainty and are stimulated by generating practical solutions or approaches to complex problems.
   b. This core of expertise could be encouraged to work intensively on specific challenges, perhaps through extended intensive workshops or "sandpits"

   Through these activities it might be possible to assemble a self-teaching network through a cascade monitoring process

3) Building and sustaining the community
   a. Opportunities for university-based projects or summer schools providing a mixture of academic content and experiential –based learning
   b. Opportunities for internships, exchanges to work on specific projects which have a system innovation character

The ERANet resource would be used within this option mainly for priming activities, through developing strong content and providing a community manager to provide structure and support in the early stages. Supporting dissemination and communication services need further identification and development under the present project and/or the future Eco-Innovera network. Once the community achieves critical mass, it is expected that other organisations might be persuaded to support delivery of specific tasks.

Within this option there would be roles for:

- Research funders to develop customised content and training
- Innovation agencies to help identify the challenges, bring business champions into the community
- Policy makers to develop national programmes, host events, acting as problem-owners for complex, multidimensional challenges
- National / regional partners to help define challenges which have a geographical dimension

Activity 2: Influence funding of system innovation

ECO-INNOVERA has a limited amount of funding within its direct control in the form of the two joint calls envisaged during the first four years of the network's life. More substantive and sustained support will be necessary if system innovation is to be implemented at scale and a rate sufficient to meet the substantial environmental challenges with which Europe is faced. A distinctive and valuable function of the network would be for it to act as an advocate for system innovation, providing the necessary arguments, evidence and practical support to make a compelling case to funders at a European and national level.

We see a role for ECO-INNOVERA to influence and leverage funding through embedding system innovation in existing innovation programmes and identifying new finance mechanisms for creating system innovation solutions and removing barriers to system change. This could include activities such as:

1. Map how system innovation is currently supported through national and EU programmes, identify candidate programmes and networks to which these approaches can be extended and/or pilot new approaches, particularly those which focus on the implementation of system innovation
    a. Large scale system innovation demonstrators – for example several member countries currently have or are developing Future Cities programmes which have a high system innovation character
    b. "Sandpit" funds (a model whereby funding is allocated after an intensive structured workshop, effectively being a form of highly collaborative proposal development in response to challenge identified by the funder)
    c. Linking to business networks which are trying to support system innovation, in particular targeting SMEs. This is linked to deliverable 1.6 of the project (a report to ETAP on supporting eco-innovation in SMEs).
2. Promote an EU-wide standardised approach o support for system innovation, including:
    a. Embedding system innovation funding criteria for projects that require a systems thinking approach. This would involve identifying and supporting flagship system innovation projects, probably linked to recognised societal grand challenges

    b. Providing guidance and training for a cohort of evaluators to assess these types of projects

3. Develop a programme for dissemination of system innovation projects and related research areas including:

    a. Focus on collating/ generating research into financial mechanisms to address barriers (for example green procurement as a driver for innovation)

    b. Task groups with expertise in on specific system innovation challenges

    c. Recognizing that different countries/ regions have different starting points in terms of their understanding and support for system innovation, and tailoring the ECO-INNOVERA support to them accordingly.

    d. Linking to a community of practitioners (see above)

ECO-INNOVERA is well placed to deliver this option through its links to the Commission and national/regional funding agencies. There is a significant opportunity over the next 12 months to influence H2020 priorities and the Eco-Innovation Action Plan.

Discussion and next steps

The objective of this document is to identify and prioritise value-adding activities for a large and diverse network of 24 partners. The experiences and contexts of those partners vary, and so a range of activities needs to be considered. To this extent, the objectives of ECO-INNOVERA mirror the requirements of the "Eco-Innovation Challenge" as described by the EIO: both to deepen and broaden the impact of conventional or "incremental" eco-innovations and to promote more radical or system eco-innovation.

We have developed two frameworks which can be used to analyse and better understand the complexity of the eco-innovation landscape. The framework developed by CML is primarily oriented towards policymakers and has reached a stage of maturity such that no further development is envisaged within the ECO-INNOVERA project.

The eco-innovation landscape developed using the Sharpcloud will be further tested, populated with appropriate content, and published through the ECO-INNOVERA website. In principle, this landscape could provide a repository of expert information for communication and awareness activities, and to connect actors and platforms at the European level (e.g. ETPs and EIPs). We will assess its utility for this purpose and scope for maintaining the landscape beyond the duration of the project.

The EU Commission recognizes the value of frameworks for eco-innovation and is willing to finance further work within the 7th Framework Programme. After the final decision for funding has been taken we will work closely with this project to pass on the learning through our work on frameworks and influence future work in this area.

Our work on metrics has revealed a great diversity, both in terms of the approaches employed and the practices of the network partners in using or specifying them. For the purposes of the 2nd joint call, an overly-prescriptive approach is not appropriate, but we will provide guidance notes to applicants on good practice, such as the IWT sustainable technology development framework.

The application of metrics to system innovation activities (both as a topic of the 2nd joint call and our wider programme) is particularly challenging. . We will assess the role of metrics in supporting these on a case-by-case basis. This is appropriate because the methodology and approach to be used must be informed by the dimensions of the particular system under consideration, and the nature of the benefits that innovation is intended to produce. Intuitively, if system eco-innovation is suited to large improvements in performance (e.g. Factor 4 or 10) then it should be possible to devise metrics to support it, provided a suitable reference situation can be defined.

We have made progress in understanding the definition and characteristics of system (eco)innovation, and identified this as an area of high-value for further development. Our objective is that by 2016, Eco-Innovera is seen as a key resource on system (eco)innovation in practice and for policy support.

Supporting this we have identified two areas of activity to be taken forward by the network:

1. To build a community of practitioners which effectively is a strategic network of: thought leaders for system change, facilitators to help others use the tools, cascade mentoring.
2. To promote ways to make funding more widely available for delivery of System Innovation projects – pilot projects, new funds, funding criteria etc.

Within these areas of activity, we have identified a range of (somewhat aspirational) sub-tasks. Recognising the resource-constraints of the network, our immediate prioritization of activities is as follows:

- Broadening and deepening understanding of system (eco)innovation:
    - Among network partners
    - Working with partner networks and projects to identify the scope to support system innovation within their programmes. We will screen potential partners mainly on the basis of to what extent their research activities support a major societal/environmental challenge
- Connecting active practitioners: in the first instance this is likely to be a web-based presence or forum but could be extended to include participation at conferences etc.. This links to tasks 4.1, 4.2 (Dissemination and web-development) of the project.
- SMEs are a prime target audience for the introduction of system eco(innovation), either because they are developers of disruptive technologies or transformative approaches, or because they tend to be more flexible and faster to respond to emerging societal challenges than large enterprises.
- Map how system innovation is currently supported through national and EU programmes, identify candidate programmes to which these approaches can be extended and/or pilot new approaches
- In particular, we will seek to influence the specification of large scale system demonstrators to incorporate a system innovation approach at the level of individual network partners, or at EU level (for example through Action 2 of the Eco-Innovation Action Plan)
- Disseminate details of system innovation projects and related research . This could include through use of the eco-innovation frameworks discussed previously. This complements dissemination activities with workpackage 4 of the project

Finally, it is noted that system innovation by its nature is complex and cross-cutting and may entail working with partners representing sectors not formally in the scope of ECO-INNOVERA (i.e. energy and transport).

Appendix 1: Research approaches to System Innovation

System change has gained considerable attention recently in business and policy communities and the concept has also shaped discussions at ECO-INNOVERA to a significant degree. System change refers to *"synergistic and broad-based changes in organization, institutions and structures, which enable future wellbeing and sustainable developments while also creating new business opportunities for businesses globally"* (Valovirta et al. 2011).

This definition is a good starting point as it highlights that system changes occur at different levels of the economy and can be significant in nature and by impact. Nonetheless, the definition also raises a range of questions in need of clarification. For example, which types of changes are we talking about more precisely and how can system changes be identified and conceptualized? Which are the main drivers for system changes, what role could policy play in initiating and directing such broad-based changes? Can we always assume that system changes have a positive impact on wellbeing and sustainable development, and how can companies benefit?

This appendix seeks to clarify system thinking from the viewpoint of ECO-INNOVERA, based on the academic literature and workshops held in February and August of 2012. It also draws on a recently concluded innovation research project funded by Tekes. We discuss some of the reasons behind the growing interest in system change, followed by a brief overview of main theoretical approaches to frame the concept.

Why has the interest in system change grown recently?

Recent interest in system change has emerged for many reasons. Numerous empirical studies over the years have come to a better understanding of dynamics and nature of innovation, especially related to the cumulative and path-dependent nature of innovation-driven change in companies, industries and societies. Cumulativeness and path dependency have been shown to hinder broad-based shifts from one innovation pathway to another, for example due to vested interests, related fixed investment and other shifting costs. Concepts such as network externalities, systemic innovations, system change and transitions, change of socio-technical systems and paradigms have gained in prominence as interpreters of challenges and opportunities related to such shifts. Examples include the shift from VHS to DVD and Blue Ray video recorder systems (company level), the ongoing shift from fuel to electrical vehicles (ecosystem level), or the shift from carbon to non-carbon energy sources at the level of economies and societies.

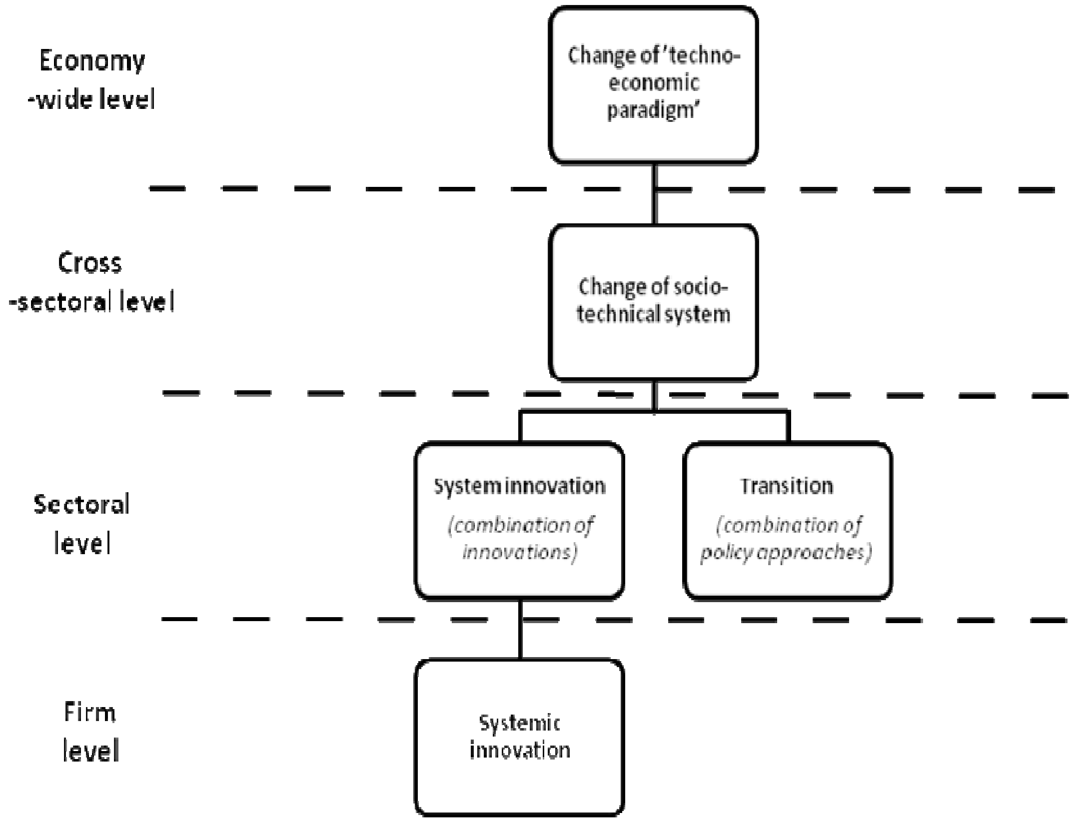
Innovation research has helped in conceptualizing system changes although it is fair to say that the level of system-thinking still is low in the policy community. Instead policymakers have been confronted with the phenomena head-on due to compounding and interrelated global challenges which are highly systematic in nature. Examples of global challenges include access to clean water and affordable healthcare, poverty, energy scarcities, and climate change as probably the most challenging of them all. Common to challenges of this magnitude and complexity is that they cannot be addressed by any single company, sector or government but rather required broad-based collaboration and synergistic actions across organizational, sectoral and national boundaries, including private-public partnerships. Global challenges thus call for system change at various levels of the economy and society.

In addition to research and global challenges, rapid technological change has also spurred an interest in system change. Emerging technologies, such as ICT, bio- and nanotechnology are converging and creating increasingly complex knowledge bases that companies have to master. Increasingly complex innovations are often mutually interdependent and also have to be compatible with critical infrastructures, such as the Internet or electric grids. Meanwhile digitalization and the age of big data open up huge new opportunities in the way in which companies and other actors can collaborate and interact globally. A result of all of this is that companies have to form new types of strategic partnerships, value networks and ecosystems, including private-public partnerships. Innovation is thus partly shifting from the level of products and services to the system level where synergistic changes in technologies, organizations, and institutions become key sources of competitiveness.

How has system change been conceptualized in the research literature?

Three broad approaches in the literature can be identified which provide different conceptualizations of system change, namely the *innovation systems* approach, the literature on *changes and transitions of socio-technical systems*, and the literature that deals with *innovation taxonomies* and their implications for management (see Figure 5). The first two approaches discuss system change at the economy-wide level or sectoral levels while the third approach moves down to the level of companies. These approaches are thus more relevant to policymakers while the third one can help companies.

Figure 5. Different approaches to conceptualizing system change



Common to innovation systems and transition approaches is that they have sought to add realism and provide alternative viewpoint to traditional policy thinking, which largely argues in term of market failures and favors market forces and technology neutrality. The innovation systems and transition approaches instead highlight a range of other types of failures which are considered especially relevant when dealing with the need for more radical and system level changes where organizational and institutional challenges also more clearly come to play. Transition of energy systems toward low-carbon alternatives is probably one of the best examples of such challenges, not least due to the important de-facto role that public policies and actors play e.g. as public utilities, regulators, procurers and users.

A core idea of the *innovation systems* approach is that technological and institutional change should be analyzed jointly because they co-determine each other. The seminal contribution is Freeman (1987) which analyzed the institutional contexts of the rise of Japan to a significant growth engine of the world after WWII. From there on the systems of innovation approach has been elaborated further at national, sectoral and sectoral levels. It addresses the systemic context of innovations by considering a broad set of innovating actors including governments, NGOs, research institutes, private companies, their interactions and dependencies on various institutions (Edquist 1997). A common trait of this approach is to say that institutions and policy governance also matter significantly for growth, especially when economies and societies have to deal with radical innovation, large scale changes of techno-economic paradigms and socio-technical systems.

A recent contribution of this approach focuses explicitly on various system-level failures which block innovation processes at sectoral level (Jacobsson and Bergek, 2011). Based on numerous empirical analysis in areas such as wind energy, biofuels, biogas digestation, and photovoltaics failures related to the absence or excess of regulations, lack of critical infrastructures, weak interactions between key actors, poor capabilities, missing joint visions and policy coordination failures, inexistence of demand or demonstration markets have been identified as key blocking mechanisms for system change. These studies are informative regarding where and how policies should promote system change and provide a whole new set of arguments for policy intervention beyond traditional market failures arguments.

The literature on *changes and transitions of socio-technical systems* offers a partial critique of the systems of innovation approach, stating that the societal context in which new socio-technical configurations are embedded has to be understood in even broader terms. Social technical configurations refer to system innovations or combinations of technological, organizational and institutional innovations where non-technological elements play a very important role. Further, the literature on socio-technical transitions extends the innovation system approach by also offering some relatively practical policy tools through which policymakers may somehow be able to steer system change and transitions in desirable directions (Geels, 2005; Rotmans et al., 2010).

System innovations emerge through the interplay between the innovation landscape, the specific sectoral environment – or regime – characterized by the knowledge base, policy mix, infrastructures, mindsets and other conditions which shape innovation, as well as local so-called niche conditions for experimentation and entrepreneurship. System innovations are at the core of transitions from one state to the next. These concepts have emerged out of extensive historical research on system change in many different sectors. If these concepts are transposed to the real-life context of transitions to low-carbon energy, climate change could be called landscape change that is challenging prevailing regimes and providing incentives for experimentation and eco-innovations at the niche level. The regime consists of current infrastructures, policies, regulations and norms which create path-dependency and provide bottlenecks and opportunities for system change.

Socio-technical transitions are continuously unfolding and their completion may take decades. What, then, could the role of policies be in influencing initiating and directing such changes? The more policy inclined strand of this literature takes a point of departure on complex systems theory where concepts such as variation, selection, attractors, feedback, emergence, co-evolution, dissipative structures, punctuated equilibrium and self-organization are prominent. Based on these concepts a so-called transition management approach has been developed to guide policymakers. Key elements of transition management include a phase of structuring the transition challenge, setting up so-called transition arenas which involve multiple societal stakeholders and forerunners (companies), enabling multiple experimentations along various transition pathways, continuous monitoring and learning, as well as processes to scale up local experiments. The approach also stresses the need for forecasting, backcasting and a strong policy vision.

Finally, the literature on *taxonomies of innovations* is the most established and oldest of all of these three approaches. Innovations have been classified from a many different viewpoints in terms of the nature and impact. In this context, the most relevant classification is originally found in Teece (1997). He made the distinction between autonomous and systemic innovations in analysis of the appropriation of innovation. An autonomous innovation is a product or component which can be used and appropriated without any changes in other products or components. In contrast, a systemic innovation requires significant adaptations or changes in other products or components. Systemic innovations thus require much created coordination during their development, commercialization and appropriation. This coordination also entails extra costs for the innovating company, for example related to development of new competencies, new business models, creation of standards and infrastructures to ensure interoperability and compatibility. Systemic innovations can have a large impact but they are also risky due the reasons mentioned above.

Research in this tradition has mainly analyzed optimal modes of organizing systemic innovation. Large coordination costs (also referred to as transaction costs) have traditionally been considered to favor vertical integration whereby a company acquires control of critical assets upstream (knowledge suppliers) or downstream (customers, retailers etc.). Nonetheless, rapidly emerging and converging technologies are creating new demands for companies to extend their boundaries beyond vertical integration as they seek to access broadening knowledge bases. Therefore systemic innovation now increasingly depend on companies abilities to create value networks and ecosystems around complex product and services systems (see also the literature on complex product systems, see e.g. Davies (1997) for a seminal contribution). These value networks and ecosystems also depend on modularization and standardization of technological and business interfaces. Finally, rapid development and diffusion of ICT solutions are important enabling factors for value networks, ecosystems and more open forms of innovation.

This literature on systemic innovation, and their implications for management, can be interpreted as complementary to the innovation systems and socio-technical transition approaches. It can help in understanding how companies develop systemic innovations, and related business models, which may become core drivers for transitions if policies and the broader societal regime also work in the same direction. Systemic innovations can be considered at the 'hard core' of what was earlier defined as system innovations, which also highlights other social and institutional complementary developments. Examples of systemic innovations include mobile telecom systems, electric cars or integrated factories. When such systemic innovations become embedded in societal systems of communication, transport and local production systems one could talk about system innovations with potentials to fuel broader socio-technical changes.

References

Bleischwitz R, S Giljum, M Kuhndt, FSchmidt-Bleek (2009): Eco-Innovation: Putting the EU on the Path to a Resource and Energy Efficient Economy, Wuppertal Institute for Climate Environment and Energy. Available at http://wupperinst.org/uploads/tx_wupperinst/ws38.pdf

Carillo-Hermosilla J, P del Rio Gonzalez and T Konnola Eco-innovation: When sustainability and competitiveness shake hands, Palgrave Macmillan 2009

CML 2012 (Ruben Huele and Gjalt Huppes): Developing and Evaluating Eco-Innovation Programmes and Projects: A Framework-based perspective. Available from http://www.eco-innovera.eu/publications

Davies, Andre. 1997. The Life Cycle of a Complex Product System, Andrew Davies, *Int. J. Innov. Mgt.*, 01, 229 (1997).

Edquist, Charles (ed.). 1997. Systems of Innovation: Technologies, Institutions and Organizations, London (Pinter Publishers/Cassell Academic)

EIO (2010). Methodological Report. Eco-innovation Observatory. www.eco-innovation.eu

EIO (2011) The Eco-Innovation Challenge: Pathways to a resource efficient Europe, Annual Report 2010 (published May 2011)

EIO (2012). Closing the Eco-Innovation Gap: An economic opportunity for Business. Annual Report 2011 (published February 2012)

Freeman, Christopher. 1987. Technology Policy and Economic Performance: Lessons from Japan, Pinter Pub Ltd, 1987.

Geels, Frank. 2005. Technological Transitions and System Innovations: A Co-Evolutionary and Socio-Technical Analysis. Edward Elgar Publishing

Grin, Johna, Rotmans, Jan, Schot, Johan (eds.). 2010. Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change. Routledge.

OECD (2009): Sustainable Manufacturing and Eco-innovation: Framework, practices and measurement. Synthesis report. OECD Paris.

OECD (2011): Better Policies to Support Eco-innovation. OECD studies on Environmental Innovation. OECD Paris.

Renning K, Markewitz P & Vögele S, 2010: How clean is clean? Incremental versus radical technological change in coal-fired power plants. Journal of Evolutionary Economics

Staffan Jacobsson and Anna Bergek. 2011. Innovation system analyses and sustainability transitions: Contributions and suggestions for research Environmental Innovation and Societal Transitions, 2011, 1(1), 41-57.

Teece, David et al.1997. Dynamic Capabilities and Strategic Management , *Strategic Management Journal*, Vol. 18, No. 7

Valovirta, Ville et al. 2011. System innovation challenges – Case studies and policy viewpoints (in Finnish). Tekes katsaus 286/2011.