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“Innovation and sustainable development: Linkages and perspectives for policies in Europe”

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The main challenge towards the transition to greener, cleaner and more equitable economic growth is to address innovation not only from an economic, but also from a social and environmental dimension. The interface between innovation and sustainable development is difficult to capture, as both are horizontal policy fields, sharing facets with each other and with other policy areas. Various paradigms in research and policy have shaped the directions of innovation, based on the prevailing economic goals in policies, institutional arrangements, and societal values. For centuries, the concept of innovation has been primarily related to economic issues, but environmental and societal pressures have spurred the rethinking of innovations in the context of sustainable development. In the political arena, increasingly stringent economic competition, unequal access to scarce natural resources, an aging workforce and environmental degradation have motivated European institutions to go beyond a traditional understanding of innovation, which focuses mostly on technological solutions and scientific innovation linked to market developments. New innovation concepts such as “eco-innovation”, “social innovation”, “open innovation”, or institutional, governance and organisational innovation are increasingly regarded as a “window of opportunity” for the markets and society to move towards societal progress with an equal, low-carbon and knowledge economy. As innovations are regarded as a means towards this transition, an integrated perspective between social, economic and environmental dimensions should be held in the centre of attention. This report therefore aims to frame the discussion on innovation and sustainable development by outlining various recent concepts, approaches and paradigms, as well as assessing recent European initiatives and some examples of good practices at the national level, in the understanding and vision of innovation.

This Quarterly Report (QR) is divided into four chapters. The first chapter includes a reflection on the various paradigms related to innovation in the political and scientific debates. It also introduces a definition of innovation and related concepts to be found in individual initiatives presented in the second and third chapters (such as eco-efficiency, circular economy, life-cycle approach, dematerialisation and decoupling) and outlines why innovation is currently on the political agenda. The second chapter shortly outlines the European 2020 flagship initiative Innovation Union and the approach it takes to integrate the environmental, economic and social dimensions of innovation for sustainable development. The third chapter highlights some of the recent innovation initiatives on the Member-State level (Finland, France, Germany and the Netherlands), focusing on innovation leaders’ strategies towards innovation for sustainable development. In the fourth chapter, the report sketches future challenges related to innovation policies which can serve as a basis for further discussions.

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1 The scientific and political debate on innovation

This section of the QR provides clarification of the concept of innovation, its context and related types of innovation (incremental, radical versus product process or systems, versus component or architectural innovation). This is followed by an overview of the main paradigms shaping innovation policies linked with the concept of innovation is provided (i.e. neo-classical environmental economics, evolutionary economics). Finally, the conceptual interface between innovation and sustainable development is clarified, and a clearer definition of innovation towards sustainable development is presented.

1.1 The concept of innovation

The most basic definitions of innovation suggests that it is change or novelty induced by human creativity. Innovation is the result of an iterative process of interaction between individuals, organisations (i.e. firms, universities), systems and institutions using price signals or other signals to find the direction in which to develop (Lambooy 2005). It is the result of both individual actions and interactions with "environments" such as markets, organizations, systems or institutions. Innovation can revolutionize organization and markets, or it can alter them only marginally. System-changing innovation should go beyond technological innovation, and include organizational innovation as well as policy to affect the transition.

The literature does not distinguish very well between environmental and non-environmental innovations (Hellström 2007). However, these two broad categorizations should be distinguished and sustainability efforts mainly concern environmental innovations. Environmental or eco-innovations are all measures of relevant actors (i.e. firms, politicians, unions, associations, churches) which:

- develop, apply, or introduce new ideas, behavior , products and processes;
- contribute to a reduction of environmental burdens or to ecologically specified sustainability targets (Klemmer et al. 1999).

The context of eco-innovation may determine how successfully the innovation is received and diffused, but finding opportunities for innovation first requires an understanding of where it comes from and which direction the innovation should take (increasing quality of products, improving ecological environment, diversifying products, etc.). The opportunities and barriers can be analyzed from various perspectives: firms and other organizations, systems, institutions, individuals, organisations (Lambooy 2005, Ramadani & Gerguri 2011). Sources of innovation include unexpected events, disagreements, new or changing requirements, changes in context or perception, and the most commonly identified source: new knowledge (Ramadani & Gerguri 2011:105).

Innovation can be defined along following dimensions:

- *Product, process or system*: Based on the Schumpeter's typology, innovation can be subdivided into product ("new good") or process ("new method of production") (Del Rio et al. 2010; Hellström 2007). System innovation refers to changes in various

systems such as industrial societal, behavioral and market changes (Bleischwitz et al. 2009). The system innovation can alter the conditions of old systems, such as those of markets, by creating new frameworks. Key words in this area include the concepts of life-cycle analysis, dematerialization, closed-loop-material cycles, decoupling, sustainable production and consumption, eco-sufficiency, user oriented systems and sustainable lifestyles (ibid.).

- *Incremental or radical*: The innovation can also be distinguished by the *newness of the offering*. The *incremental innovation* is based on a new technology or process which is marginally different from its predecessor. The *radical innovation* introduces new technologies and processes which are significantly different from the predecessor (Bleischwitz et al. 2009). It has been argued that an industry will face decreasing marginal returns on its incremental eco-innovation efforts in terms of sustainability and financial improvements. Therefore, it is pertinent to regularly generate radical eco-innovation in order to push the technological system up to a new equilibrium (Murphy & Gouldson 2000).
- *Component (modular) or architectural (systemic)*: Component innovations take place when one or more modules integrated within a larger system are replaced, while the system itself stays intact. An architectural innovation, on the other hand, entails changing the overall system design and hence the way the parts interact with each other. (Hellström 2007). It is difficult sometimes to clearly distinguish between those two concepts empirically, as it involves decisions on system boundaries (ibid.).

The features mentioned above are shared commonly among various types of innovation, such as technological, institutional, organizational, open and social innovation. Although the innovation concept is founded in the economics disciplines, its theoretical definition stretches across many other ones. *Organizational innovations* are, for example, management instruments at the firm level, like eco-audits, which are of increasing importance for innovation (Rennings 2000). *Social innovations* are often defined as changes of lifestyles and consumption patterns. The idea of social innovation is new, but increasing in popularity as policy makers recognize that effective environmental policy-making requires understanding of lifestyle dynamics (Duchin 1999). Recent trends in research and development for private firms are encouraging *open innovation*, which may encourage spillover within a national economy. Forms of open innovation include: the "outside-in" process, in which companies speed their own innovation by creating innovation networks, from which they can harness external knowledge of customers, suppliers, etc; the "inside-out" process, in which companies seek to externalize their own knowledge and innovative ideas in order to bring them to market more quickly and thus speed market innovation; and the "coupled" process, in which the former two processes are combined, helping companies to "jointly develop and commercialize innovation" (Enkel et al. 2009: 312-313).

1.2 Paradigms for innovation policies

The literature on innovation is substantial and covers a wider range of topics (Dalglish & Newton 2002), generally focussing on patterns of innovation and its diffusion, the relationships between organisation structures and technological capacity (Kantner 1988, Burns & Stalker 1961), and the process of innovation and the economic factors determining the development of innovation (Kay 1993, Rogers 1983). Studies on the role of innovation in

economic, social and environmental change show a cross-disciplinary trend. This reflects the facts that no single discipline deals with all aspects of innovation (Fargeberg, 2003). However, in the academic field, various paradigms in the environmental economics and innovation economics disciplines have prevailed in framing innovation as an engine for the economy, societal progress, and environmental wealth (Del Rio et al. 2010). Before we try to identify how innovation towards sustainable development is understood, we summarise shortly the existing disciplines and existing approaches in which innovation is dealt with.

Innovations studies distinguish among the environmental (eco-innovation) and non-environmental innovation. The disciplines dealing with eco-innovation are innovation economics and environmental economics. Within these categorisations, environmental and innovation economics can take various approaches how to regard at innovations: the neoclassical approach and the evolutionary approach feeding the policy debate.

The *neo-classical approach* of innovation economics puts *knowledge, technology entrepreneurship and innovation* at the center of the growth model (Solow 1957) and drive economic growth towards a knowledge based economy. Joseph Schumpeter (1942) classically regarded the innovative activity of entrepreneurs as process of "creative destruction"², which leads to change in an economy or transformation of society (Lambooy 2005: 1140). According to Schumpeter, innovation not only leads considerably to higher productivity and economic growth as main economists think, but also leads to changes in economic structures, which could be also named "creative construction" (Lambooy 2005). In innovation economics, the innovation approach to growth has looked at the positive spillover effects of basic R&D in firms (Romer 1986). The implications of this model are that investment in human capital and R&D generate increasing returns to growth. The more knowledge (technology and human capital) there is, the more productive R&D efforts using human capital are. The main discussion on innovation economics has been whether technological innovation has been driven by technological development (technology push) or by demand factors (market or demand pull). Empirical evidence has shown that both are relevant; however, the pull effects remain restricted to the market economy and do not include societal values and behavioral change towards those innovations.

Another discipline of economics dealing with innovation is *environmental economics*. The focus of this discipline is on the *market failure framework* and *environmental externalities*. The reliance on market-based instruments and efficiency of those instruments to promote innovations (taxes, tradable permits) and to correct market failures for eco-innovation has not proved to be effective (Del Rio et.al 2010, Nill & Kemp 2009, Smith et al. 2010). This approach suffers from a simple mechanistic stimulus-response model of regulations (Smith et al. 2010), neglecting the complexity of determinants beyond markets influencing decisions in firms, in society and in politics. Its approach is static and therefore does not offer solutions to "lock-in" situations of certain unsustainable technologies (Nill & Kemp 2009). They have a limited value for the analysis of more radical changes of technological systems and societal

² The book also introduced the term 'creative destruction' to describe innovative entry by entrepreneurs was the force that sustained long-term economic growth, even as it destroyed the value of established companies that enjoyed some degree of monopoly power. Because of the significant barriers to entry that monopolies enjoyed, new entrants would have to be radically different: ensuring fundamental improvement was achieved, not a mere difference of packaging. The threat of market entry would keep monopolists and oligopolists' disciplined and competitive, ensuring they invest their profits in new products and ideas. Schumpeter believed that it was this innovative quality that made capitalism the best economic system (Schumpeter 1942)

context towards sustainable development (Smith et al, 2010). In the 1980s, a reform-oriented school of economics and environmental studies named **ecological modernisation** gained increasing attention among scholars and policy-makers (Huber 1982, Simmonis 1989, Mol et al. 2009). Work on ecological modernisation grew out of the belief that the decoupling of economic growth from environmental destruction may become “an emerging feature of certain advanced industrial economies” (Baker 2006). Technological innovation was supposed to achieve not only economic growth but ‘**dematerialisation of economic growth**’³ – e.g. an increase in resource efficiency by a factor of 4 could result in the doubling of GDP with only half of the original resource input (von Weizsäcker et al. 1995; see also Schmidt-Bleek 1998).

The other paradigm to the neo-classical approach, arising more from heterodox economics, is based on *evolutionary economics* (Nill & Kemp 2009). This approach goes beyond deterministic, static neo-classical models, considering the system failures to facilitate the structures, which may be “ill-developed for innovation” (Nill & Kemp 2009: 668). It opens up the “box of surprises” being connected with radical changes, beyond market economies (Smith et al. 2010): unpredictable interactions of sub-systems, irreversibility and path dependency. This approach is more interested in transition processes, such as how to transform the economy into a more resource efficient and green economy (Nill & Kemp 2009) and to explain the “lock-in” of certain technologies and innovations. The evolutionary economics paradigm, therefore, provides a “helpful corrective” to (neo-classical) environmental economics (Smith et al. 2010). As the latter sees the challenge only in predominantly adjusting market based instruments (prices, taxes) and relies mostly on *demand-pull* approaches. The evolutionary approach takes in consideration also *many non-market constraints* (institutional, societal and political barriers) to the supply side of innovation and why market based-instruments do not lead to a promotion of green innovations (Nill & Kemp 2009). Evolutionary perspectives are expected to gain importance at the policy level (Nill & Kemp 2009). Methods used at the policy level are transition management, strategic niche management, and time management. However, the policy effectiveness of the evolutionary approach in cases in which radical or systemic changes are involved is not yet proven (ibid.).

1.3 Innovation towards sustainable development

Through many initiatives at the international and national level, there is a general necessity to develop a vision of the relationship between technology development, innovation, the functioning of institutions, and societal progress. The main challenge towards the transition to greener, cleaner and more equitable economic growth is to address the innovation issue not only from an economic, but also from a social and environmental dimension (Bleischwitz et al. 2009), which has also policy and governance implications. This requires, according to the three pillar model of SD, that innovation should be socially, environmentally and economically sustainable, optimizing all of these developments together. The integration of sustainability into innovation policies is not an easy task (Hines and Marin 2004). However, many efforts in science and policy are attempting to better define “societal progress”, and to

³ In economics ‘dematerialisation’ refers to the absolute or relative reduction in the quantity of materials used as input in an economy in relation to GDP (von Weizsäcker et al. 1995). Dematerialisation is essentially the reduction of throughput of materials in human societies. It can be measured in relation to geographical economic units (nations, regions, cities) but also to industrial sectors, households or products.

better integrate the evolutionary approaches into sustainable innovation policies. Many articles refer to eco-innovation as innovation lying at the heart of sustainable development (Rennings 2000, Hellström 2007). Therefore, we first define innovations for SD, and then also the eco-innovation concept and its limitations towards sustainability goals.

1.3.1 Definition of innovation in the context of sustainable development

Based on the innovation policy paradigms demonstrated in this chapter, this part attempts to conceptually define the framework for innovation in the context of SD. Despite the problematic issues in defining the innovation concept, some generalisations could be made concerning the nature of innovation towards SD. SD emphasises the explicit interest of the normative direction of development, taking into consideration the balanced three-pillar approach (economic, environmental and social sustainability). Hence, the innovations for SD do not remain neutral, and take a normative direction. The challenge for innovation does not rest solely on economic benefits and opportunities, but also in the societal changes induced by innovative capacity and the consequences of this for the environmental and social sustainability. The latter definition goes beyond the traditional Schumpeterian interpretation of innovation (Hines & Martin 2004). Moreover, irrespective of the specific nature of the SD approach under consideration in public strategies (e.g. deep cuts in green house gases, step change improvements in resource efficiency, delivering the Millennium development goals), the "need to escape lock-in, deflect path dependencies and transform socio technical regimes becomes paramount" (Smith et al. 2010: 441). New transformational and transition management policy strategies are needed, looking at the necessity of changing the roles of different stakeholders and reinventing the institutional set-up of societies (Hines & Marin 2010).

Based on a recent literature that reflects on redefining innovations from a SD perspective, innovations should rest on following guidelines:

- 1) System innovation approach;
- 2) Radical changes of green innovation and not only component or incremental changes, such as restructuring from a clean technology approach to industrial ecology;
- 3) Frame SD innovation policy paradigms from an evolutionary perspective on innovation, and not form a neo-classical environmental perspective;
- 4) Multiple level perspectives in socio-technical transitions.

First, innovations for SD should broaden the problem framing to a perspective on system innovation. System innovation involves the renewal of the entire "socio-technical" system: supply chains, consumption and use patterns, infrastructures, regulations, institutions, policies etc. (Smith et al. 2010:439, Bleischwitz et al. 2009). This approach suggests that innovative yet isolated technologies, no matter how green, will not contribute to holistic sustainability. "Socio-technic" transitions are increasingly seen as inherent to sustainable development, and innovation framed in this context must look past markets and towards wider societal institutions (Smith et al. 2010: 439). The key difference between the green or eco-innovation literature and the system innovation, is in the starting points and focal objectives of each. The problem framing in the green innovation literature is based on making markets more environmental friendly. The systems innovation literature frames the

problems outside the markets, basically as a "societal function" (Vollenbroek 2002, Smith et al. 2010).

Second, the environmental innovation problem should broaden beyond the technological solutions at the firm level such as the "end-of-pipe pollution control", going further to included organisational innovations across sectors and the development of green goods and services across the lifecycle. This has partly already been the case in the literature; however, further attempts need to be made in order to frame the environmental problems more broadly, beyond cleaner technology at the firm level, to consider entire sectors and lifecycles of products (Smith et al. 2010).

Third, innovations studies and paradigms for SD should take an evolutionary approach (as described in sub-section 1.2) in understanding innovation dynamics for sustainability. Neoclassical approaches are insufficient in explaining the determinant affecting the supply side of innovation, as they focus mostly on markets demand-pull control and "right price signal". The evolutionary approaches also include non-market-determinants such as decision making at the firm level, institutional factors, knowledge capabilities, prevailing technology paradigms and regimes (Kemp 1994). Moreover, they do not take a deterministic and path dependent view as the neoclassical approach, which helps understand how to improve radical changes toward a resource efficient economy.

Fourth, as SD remains a normative concept, it needs an approach towards innovation that involves the society, characterised as "society pull". This means to promote a change in socio-technical systems that can help realise broad social functions more sustainably (Vollenbroek, 2002: 215). Various actors have to define what should be the balance of economical, environmental and social goals that are to be met. The approach offered in the literature for this participatory process is the multi-level approach, which provides a straightforward way of ordering and simplifying the analysis of complex large structural transformation in production and consumption demanded by the normative goals of SD (Smith et al. 2010 : 442). The multilevel approach is based on new modes of governance are such as transition management, strategic niche management, which might accelerate the take off of some green niches and restructure the production and consumption process (for these new policy approaches see Nill & Kemp 2009).

1.3.2 Eco-Innovation and its contribution towards sustainable development

Environmentally oriented innovations, also known as eco-innovations, bring the sustainable development realms of economy and environment into play, and also have an inherent effect on the social part of sustainable development. The concept of eco-innovation is mostly discussed in the literature as the innovation concept that is most embedded in the context of SD. Eco-innovation is defined as innovation which lessens environmental burdens or contributes to sustainability goals (Rennings 2000: 322) and is also said to improve the environmental performance of consumption and production activities (Del Rio 2010: 542). Eco-innovations are based on the imperative of eco-efficiency of the World Business Council for Sustainable Development (Hellström 2007). Due to rebound effects, the extent to which eco-efficiency or broader resource efficiency leads to reduction of environmental burdens is still not very straightforward (Gjoksi & Sedlacko 2011). If eco-innovation should be assessed in the context of SD, the concept shows following weaknesses:

First, eco-innovation focuses mostly on the environmental side of the market economy (production and consumption of goods and services) and does not properly include social innovation. Innovation concepts for SD strive for an approach in which technological solutions are linked better with societal values and lifestyles together directing innovation towards progress. (Vollenbroek 2002)

Secondly, the impact that eco-innovation will have in directing and transforming our economies and societies is still questionable (Hellström 2007). The routes that eco-innovation is most likely to take today are based on *component innovation* and *incremental* ones, i.e. producing components in slightly different ways, moving from offering a product to offering a service, the elimination of polluting product components, new clean replacement technologies, etc. (Hellström 2007: 152). Incremental innovation, understood as the substitution of product and process with more environmental friendly ones, still satisfies a certain existing demand. Therefore, such innovations conform to the existing model of consumption patterns and try to satisfy the current level of demand. However, as the literature questions the potential of incremental innovation to "drive radical product or process innovation for global markets" (Hellström 2007), sustainable development needs a more radical approach in terms of technological solutions. Researchers have often expressed the need for radical, systemic technological changes in order to achieve demanding environmental sustainability goals (Nill & Kemp 2009, Hellström 2007). The radical and architectural process innovations are the innovations that are least understood in the literature and also least applied in practice (Hellström 2007).

Thirdly, the eco-innovation impact in radically changing the whole production system is still not very well elaborated in the literature, as there are many types of eco-innovation. As supported from an empirical study, eco-innovation based only on technological improvements for the purpose of more resource efficiency seems to be biased away from the type of eco-innovations which have the potential to realizing sustainable development (Husemann 2003). Moreover, even when radical architectural innovation leads to improvement in the production process, the social system with its institutions, cultural settings, and life-style and consumption patterns will set limits to incremental or even radical technological development. Innovations based on technological improvements do not automatically lead to societal progress, as is implicitly assumed in technology push-oriented policies (Vollenbroek 2002). The eco-innovations that are most likely to succeed in pushing the economy towards sustainable development will be those ones which include the social and institutional dimension in the innovation of ecology and economy (Smith et al. 2010, Vollenbroek 2002). The most applied incremental innovations, on the other hand, seem to lock social practices into existing trajectories which then become increasingly more costly to break out (David 1985).

2 Overview of the European initiative on innovation

Public strategies that aim to better link economic growth and environmental protection are currently focussing on concepts such as resource efficiency, dematerialization of economic growth by factor 5 or 10, absolute decoupling and eco-efficiency. Despite differences among

these concepts, commonalities exist in the recognition of the fact that the promotion of eco-innovation or environmental friendly innovations have the potential to change the way economies and societies consume resources and pollute the environment. The EU's new development strategy, [Europe 2020](#), identifies three mutually reinforcing objectives of "smart, sustainable and inclusive growth" which are defined in seven flagship initiatives. Three of these initiatives have potential relevance to innovation, such as: the flagship initiatives on the [innovation union](#), on [resource efficiency](#), and on [industrial policy](#). With regard to resource management, there is no detail yet on how resource efficiency is to be understood or how it can be achieved thorough innovation activities (IEEP, 2011). With regard to industrial policy, the EU is mostly emphasizing the innovation-driven growth approach, by securing a strong industrial base and ensuring competitiveness. In the following sub-sections, the innovation flagship initiative will be shortly outlined.

2.1.1 Innovation Union Flagship initiative

The EU's new development strategy, Europe 2020, identifies three mutually reinforcing objectives of "smart, sustainable and inclusive growth", built upon seven flagship initiatives. A number of these flagship initiatives with a focus on resource efficiency ("Resource efficient Europe"), ("Innovation Union") and industrial policy ("An industrial policy for the globalisation era") have potential relevance to the innovation topic. Europe has set the target of reaching 3% of spending of the GDP in R&D by 2020. This would create 3.7 million of jobs and increase GDP. Investment in R&D is mainly seen, therefore, as a contribution to growth and employment (European Commission 2010). The innovation-driven economic growth approach seems weakly linked with innovative concepts of innovation for SD mentioned in chapter one.

The targets of the Europe 2020 flagship initiative innovation union are to (European Commission 2010):

- strengthen the knowledge base by promoting the education and skills development; by delivering an European Research area; and by focussing the European funding instruments on Innovation union priorities;
- get good ideas to market by creating better access to finance for enterprises and creating a single innovation market;
- increase social and territorial cohesion (increasing social benefits and better spreading the benefits of innovation through the member states).

Based on the flagship initiative innovation union, it seems that policy does not "yet appear to reflect sufficient understanding of the links between research and development and the design or manufacture of products or their management at the end of their lives" (IEEP 2011: 13). Therefore, it does not serve very well as a guiding strategy for better linking research and markets towards innovation for sustainable development. The focus of the goals in the innovation union flagship are to tackle "all societal changes" mentioned in the Europe 2020 strategy, such as an aging population, the environmental issues related to climate change, energy and resource scarcity (European Commission 2010: 23). It mentions the need for more open innovations as well as more room for social innovation experimentation: "Social innovation is an important new field which should be nurtured [...] to find new ways of meeting social needs which are not adequately met by the market or the

public sector [...] (European Commission 2010: 21). However, concrete measures to the committed goals are still lacking in the flagship initiative.

Its only reference concerning the promotion of eco-innovation is in the “narrow confines of eco-innovation action plan” (European Commission 2010: 17). This action plan will be presented later in 2011 and should complement the Innovation Union by focussing on specific eco-innovation bottlenecks, challenges, and opportunities for expanding the focus of innovation policies towards green technologies and eco-innovation (Martin 2011). The eco-innovation action plan identifies the following challenges and actions: (1) the need for stricter regulations on innovation towards environmental sustainability; (2) the need to mobilise the financial resources for eco-innovative enterprises; and (3) the need to better promote the environmental technologies in developing countries through ad-hoc partnerships (Martin 2011). Against this background, the countries need to screen the regulatory framework and understand which gaps exist for the promotion of environmental innovation. On the other hand, the European Commission sets clear commitments in providing guidance to Member States for such screening. (European Commission 2010: 17). Furthermore, there is a need to mobilise the financial resources for eco-innovative enterprises and better promotion of environmental technologies in developing countries through ad-hoc partnerships (Martin 2011).

Until now, there is no mention of overarching political objectives to be met beyond tackling “societal changes”. There is no indication of quantifiable targets for innovation in the dematerialisation factor or in the material efficiency gains, neither “if societal changes mean innovating towards CO₂ reduction of 20% or 80% by a certain year” (IEEP, 2011: 13). Based on the flagship initiative, the European innovation policy is insufficiently guided toward sustainable development at the moment. This policy will need to become clearer about targets and ambition if innovation is to be guided appropriately towards achieving specific outcomes for sustainable development.

2.1.2 Horizontal linkages of the Innovation Union with the resource efficiency and industrial policy

The resource efficiency agenda, based on the Commission’s 2011 flagship initiative on resource efficiency within the context of Europe (developed within Europe 2020 process), is presented primarily as an economic and competitiveness issue, with the environmental dimension less prominent. This underlines the need to increase the profile of the environment in the overall resource efficiency agenda and in the innovation and industrial policies (IEEP 2010).

The Commission’s 2010 flagship initiative on industrial policy within the context of Europe 2020, “[An integrated Industrial Policy for the Globalisation Era](#)”, puts also competitiveness ahead of sustainability in the innovation focus (IEEP 2011: 12). Therefore, the signals of this flagship do not instruct the producers and markets to change business models or to make improvements to products or their provision, despite the constant call for industry to contribute to a European low-carbon, resource-efficient economy.

The links between the flagship initiatives on innovation and on industrial policy should be more explicit and should take a specific focus on environmental topics, such as resource

scarcity. The link is currently limited to innovation for the purpose of securing a strong industrial base and ensuring competitiveness. Particularly, the roadmap on resource efficiency will need to make stronger links to industrial, innovation and product policies as key leverage points for intervention in the production and consumption chain. Regarding the Innovation Union, more specific targets in innovation policy might help to guide innovations more effectively towards societal changes and identify key sectors and measures where action is required. Especially, it should better differentiate radical and incremental changes that are needed to set up new markets for environmental friendly innovations, better integrate institutional and organisational innovations, and also identify the drivers and barriers for eco-innovation and the role of public policies and regulations. In the latter, it should better distinguish what concrete regulations towards which concrete targets would lead to innovation towards a low carbon economy.

3 National innovation strategies and initiatives

National innovation systems (NIS) began to be described in the late 1980s as being comprised of the efforts of and relationships between government, university, and industry in generating innovation, and the varying environments of these institutional sectors (Godin 2009: 476). Later, the OECD hoped that an understanding of the inner workings of national innovation systems would influence policy-makers into taking action towards innovation (Godin 2009: 477). In the early 1990s, Finland took the lead in utilizing the NIS framework approach for the purpose of science and technology policy (Ramstad 2009: 547-548). Currently, all EU Member States have at least one document that includes priorities for innovation policy and recognizes the needs and dynamics of their national innovation system (European Commission 2009: 18). The importance of the national innovation system was linked to the neo-classical economic paradigm regarding innovation as key to economic growth and prosperity. Only recently, political efforts are arising to better link the national innovation system and its policy manifestations with the sustainable development trajectory of a nation. In a study linking SD and innovation policy, three obstacles were listed as restraining the linkages between these horizontal policy areas: (a) lack of a common comprehension on sustainable innovation; (b) varying acceptance of innovation and sustainability in the political system; and (c) lack of power in existing policy co-ordination boards (Whitelegg & Ömer-Rieder 2005:3-4).

The Innovation Union Scoreboard (IUS), prepared by the Maastricht Economic and Social Research and Training Centre on Innovation and Technology (UNU-MERIT) in 2010, is meant to monitor implementation of the Europe 2020 Innovation Union Flagship initiative by using 25 indicators to assess the national innovation strategies and overall innovation systems of the EU Member States (UNU-MERIT 2010). The IUS ranks countries based on their innovation policy strategies, distinguishing "innovation leaders", "innovation followers", "moderate innovators", and "modest innovators". Innovation leaders are marked by a strong connection between science and business, with the highest number of public-private co-publications and strong funding for research and development.

Considering these rankings, this QR overviews the national innovation strategies of four EU Member States, two "innovation leaders" and two "innovation followers", that are all marked by strong linkages and efforts toward SD. Rather than detailing the current state or

potential of each national innovation system, and the innovation needs and challenges faced within each country (which many of the NIS documents focus on), this QR will attempt to evaluate how strongly each of the following four national strategies link innovation and growth with sustainable development. A background on each innovation strategy is given in order to clarify its structure and conceptual foundation, followed by an assessment of its connections so social and environmental sustainable development (assuming that ties to economic development are inherently strong in innovation strategies). Finally, each strategy is further assessed with a short summary of its concrete actions and measures.

3.1 Finland

Background and objectives of the innovation strategy

Finland is considered to be an “innovation leader”, as well as a “growth leader”, by the IUS 2010. The [Finnish National Innovation Strategy](#) of 2009 is characterized by public sector policies which boost innovation and research funding, in order develop knowledge and know-how in the national education system and how to utilize that knowledge in order to support innovations in the business sector (European Commission 2009a). The strategy seeks to increase knowledge transfer and cooperation between business and academia, specifically for the purpose of internationally competitive radical innovation (European Commission 2009a: 49). The Finnish Government’s Communication on Finland’s National Innovation Strategy to the Parliament, which details Finland’s NIS, describes a hope for an “experimental society” that develops innovation-based productivity and wellbeing (Finnish Government 2009: 24). A systemic, broad-based approach to innovation is taken, in which horizontal sectors (policy and business) and vertical activities (development levels) are wholly considered (Finnish Government 2009: 5).

The premise of Finland’s need for innovation is that “both the economy and society are facing immense pressures for change” (Finnish Government 2009: 5). In the Government’s Communication on Finland’s NIS, four contemporary phenomena are said to affect and steer innovation: globalisation, sustainable development, new technologies, and ageing of the population (2009:6). Immediately SD is listed as a key driver of change to the innovation environment, specifically mentioning scarcity of raw materials and the need for ecologically sustainable production and consumption (Finnish Government 2009: 5-6). In terms of innovation policy, the government chooses to focus on policies that focus on education as well as research and technology, but also emphasizes that varying types of innovation are all interrelated (such as firm innovation, organisational or institutional innovation, as well as traditional technical innovations) (Finnish Government 2009:7).

Institutions and diverse stakeholder participation

Finnish innovation policies are advised by the Research and Innovation Council, and are largely developed by the Ministry of Employment and the Economy and the Ministry of Education and Science (European Commission 2009a:14). Most of Finland’s innovation policies are implemented via the funding of the Finnish Funding Agency for Technology and Innovation (TEKES), which is a strong factor in Finland’s reputation for “forceful” innovation support (European Commission 2009a).

NIS approach to innovation towards SD

Just as the Finnish NIS recognizes SD as a force changing innovation needs, it also recognizes that innovation impacts the pillars of SD: the NIS lists the environment, economy, learning and skills, and the Finns' well-being as the four key impact areas affected by national innovation (European Commission 2009a:23). It also recognizes, in terms of sustainability, that scarce resources and an ageing population demand even greater leveraging of resources for innovation, and suggests that coming innovation must go past the traditional end of economic growth and can "[foster] sustainable socio-economic reform, and [enhance] the wellbeing of citizens and the environment" (Finnish Government 2009:5).

As previously mentioned, in 2009 Finland took a systemic approach to innovation, comprised of broad-based innovation and leadership and change management (Finnish Government 2009:16). In the NIS, an emphasis on open-innovation and customer-based approaches aligns with one of the tenets of SD for innovation, in which social demands, or "society pull" (as referenced in the theoretical portion of this report to be key for SD innovation), should steer innovation. Specifically, "a new, broad-based innovation policy will emphasize the development of products and services meeting the needs of customers, and the strengthening of users' and developers' mutual development work" (Finnish Government 2009:17). The Pro INNO Policy Trendchart Finland Country Report 2009 describes Finland's NIS as striving to move past the R&D funded, competence-based innovation approach towards a more demand and user-based innovation policy (European Commission 2009a:12). Despite these goals for societal cooperation and inclusion, the concentration of financial support flowing into TEKES is said to be increasing, reinforcing a "supply-based strategy" largely dependent on TEKES rather than a strategy that is inclusive of consumers and "society-pull". The struggle to innovate against climate change and to increase renewable energy are regarded as opportunities for increased competitiveness in the international market, suggesting that the ends of SD and economic growth can both be achieved through innovation (Finnish Government 2009:7). Hence, research and development projects on renewable energy and environmental technologies are emphasized. However, the Finnish NIS focuses largely on competitiveness and the "enhancement of productivity" (Finnish Government 2009:14), suggesting a conflict between environmentally sustainable development and Finland's innovation goals.

Actions and measures of the innovation strategy

Finland's high ranking as an "innovation leader" stems from its funding for research and development, largely through TEKES (European Commission 2009a). In this sense, Finland's support for innovation has a strong quantitative measure. However, according to the INNO-Policy Trend Chart 2009 Country Report for Finland, the Finnish NIS lacks a concrete action plan (European Commission 2009a). While innovation funding may be strong, the role of innovation for broader, social and environmental wellbeing is not fully developed with specific actions in mind for the future. This is reinforced by a lack of specific, diverse (i.e. not only oriented towards firms and competitiveness) innovation priority areas in Finland's 2009 NIS.

3.2 France

Background and objectives of the innovation strategy

Though France is considered to be an “innovation follower” by the IUS 2010, France’s [National Research and Innovation Strategy \(NRIS\)](#), developed in 2009, can be distinguished for its efforts towards linking SD and innovation in relevant policy goals. The French NRIS sets the goal of “[putting] back research and innovation at the heart of French society and economy”, and focuses on research goals, implying that this research will be transformed into innovation though recognizing that this transformation will not be spontaneous (French Ministry for Higher Education and Research 2010: 3-4). The innovation system itself is said to have three functions: policy-making, programming, and research and innovation (Ministry for Higher Education and Research 2010: 19). The 2009 document is divided into three priority areas for research and innovation: health, well being, food and biotechnologies; environment emergency and eco-technologies; and information, communication and nanotechnologies (French Ministry for Higher Education and Research 2010).

Institutions and diverse stakeholder participation

French innovation policy is steered by the Directorate-General for Research and Innovation, the Ministry of Higher Education and Research and the Ministry for Economy, Industry and Employment (European Commission 2009b:13). The diversity of actors in the French innovation system is conducive to SD, as innovation goals are not limited to the economic sector: public, private, non-profit, and civil society groups were called upon to develop the three previously mentioned research priorities for innovation (European Commission 2009b:11). The NRIS takes recommendations from the research committee of the “grenelle de l’environnement” (round table of the environment), thus suggesting a clear linkage between environmental and innovation goals. Additionally, the Ministry of Ecology, Economy, SD and Sea plays a role in the national innovation system by providing research funding, further suggesting the influence of sustainability efforts in the innovation system (European Commission 2009b:13).

NIS approach to innovation towards SD

The NRIS looks at “environmental transformation” as an opportunity for economic growth in terms of job creation and reduction of energy expenses (French Ministry for Higher Education and Research 2010:31). Environmental urgency is discussed immediately at the beginning of the document as a current major issue to be faced through innovation. This urgency is explained as a “triple challenge posed by the depletion of natural resources and the functional sharing of land, by the climate change, and by the need for relative energy independence”—thus a much more in-depth consideration of environmental SD issues when compared to other National Innovation Strategies (French Ministry for Higher Education and Research 2010:25).

The breadth of France’s SD-related innovation goals in the NRIS, particularly considering environmental sustainability, includes: technology for better measuring climate change and biodiversity (satellites, simulators), toxicology and eco-toxicology research for protecting

living organisms, eco-technology and eco-design considering life-cycle impact, improvement of photovoltaic cells, development of bio-fuel, development marine energy technology, development of sustainable cities (in terms of architecture, transport, energy storage), improvement of vehicle efficiency and the aim for carbon-free transportation. In terms of effective eco-innovations, radical innovation is even mentioned in terms of the goal for a breakthrough in technologies such as photovoltaic technology (Ministry for Higher Education and Research 2010:8-9).

There is further evidence for France's SD approach to innovation in the NRIS in terms of social issues. In fact, the NRIS includes a subsection titled "French research at the service of economic and social development" (French Ministry for Higher Education and Research 2010:21). The depth of concern for biotechnology, nutrition products for a healthy human society, developing autonomy of dependent people, fighting infectious disease, and increasing knowledge of the biological world reflect the needs of social SD. These considerations extend to the mentioning of varying definitions of "development" and social issues, such as climate change, emerging diseases, food safety, biodiversity, migration, and governance. The "innovation chain" is seen as the link connecting research, companies, and consumption, and is said to require a multidisciplinary approach, considering social sciences along with hard sciences in order to address societal challenges (Ministry for Higher Education and Research 2010:22-23).

Economic growth and competitiveness are considered in line with concepts such as open innovation and "society pull" in the French NRIS. In 2008, the Ministry for Economy, Industry and Employment and the Secretary of State for Ecology collaborated to create "Cosei", a committee for eco-industries which developed the Eco-tech 2012 plan (European Commission 2009b:4). The Eco-Tech 2012 plan includes funding for eco-technology research and development projects, further funding for the environment sector, a call for competitiveness clusters in the eco-tech field, and the implementation of two programs to control environmental norms (European Commission 2009b:4). Competitiveness clusters are meant to foster cooperation and technology exchange, thus encouraging open innovation and the participation of more actors in the innovation process (European Commission 2009b:11).

Actions and measures of the innovation strategy

The French NRIS is extensive in its societal considerations amidst the economic force of innovation, and clearly links innovation as a force for furthering SD. It is thorough in its delineation of societal challenges and goals, and solidly places innovation into the context of SD. Prior to discussing the three innovation priority areas, the document sets some guidelines as to how to support innovation, largely in the realm of private firms and international competitiveness. However, the document ends after thoroughly delineating the innovation priority areas without clarifying strategic innovation actions and steps towards these diverse, SD-related issues. This inhibits the French NRIS from generating immediate, effective innovation towards SD, despite its thorough concern for SD issues. While the French NRIS certainly frames innovation within the SD framework conceptually and idealistically, it does not detail specific, tangible steps for embedding SD concerns in the national innovation system.

3.3 Germany

Background and objectives of the innovation strategy

Germany is ranked as both an “innovation leader” and “growth leader” by the IUS 2010. Like Finland, it is marked by significant funding and investment in R&D, which reached 2.7% of the GDP in 2008 (BMBF 2010: 4). The [German National Innovation Strategy](#) goes by the name “Ideas. Innovation. Prosperity. High-Tech Strategy 2020 for Germany”, developed by the Federal Ministry of Education and Research in 2006 and updated in 2010. The document first describes a successful model for the innovation strategy, then outlines new focuses, and finally gives an overview of fields of action. The fields of action are drawn out in parallel to five global challenges: climate & energy, health & nutrition, mobility, security, and communication—thus evincing SD topic areas as a framework for the innovation plan (BMBF 2010:5). The document introduces the broad national concept of innovation as a means to “material, cultural and social wellbeing” (BMBF 2010:3-4).

Institutions and diverse stakeholder participation

The German strategy is said to “link up” various Federal Ministries for the purpose of innovation, suggesting a cross-cutting, horizontal approach to innovation (BMBF 2010:4). Most of the national innovation strategies mentioned in this QR reflect the work and responsibilities of one or two ministries (most commonly a ministry on education and a ministry related to the economy). The German system also relies mostly on two main actors: The Federal Ministry of Economics and Technology and the Federal Ministry of Education and Research, but it also relies on the Bioeconomy Framework Program (BMBF 2010). However, the German strategy, like the French NIS, incorporates even more actors than some of the strategies described in this QR. The High Tech Strategy 2020 calls for unspecified individual ministries to develop their own innovation strategies and measures (BMBF 2010:11). This allows for multiple approaches to develop and to be carried out, rather than limiting innovation policy measures by maintaining centralization within one or two ministries. The German strategy also calls for each involved ministry to finance its own measures related to the High Tech Strategy 2020 (BMBF 2010:7), thus distinguishing the German strategy from the Finnish strategy, in which innovation funding is highly concentrated within TEKES. Even prior to the High Tech Strategy 2020, the German national innovation system was described as having a clear division of labor among ministries, in terms of how innovation policy was designed and delivered (European Commission 2009c:10). Aside from their relatively diverse actor institutions involved in developing innovation policy and strategy, they have a unique system for innovation policy implementation. *Projekträger* (PT) are formally independent organisations that carry out innovation policies contractually, managing public relations, proposals, financing, monitoring, stakeholder debates, etc. (European Commission 2009c:12). These formal institutions, which function mainly to facilitate innovation policy in Germany, are unique among other national innovation systems and strategies, and prove the German NIS to be strongly embedded within the nation. In 2009, there were at least 20 PT serving federal and state ministries, allowing the ministries to focus more on the conceptual development of innovation policies and strategies, and taking full responsibility for practical implementation (European Commission 2009c:12-13).

In terms of "society pull" and socially incorporative innovation, the German strategy states that "social change is considered to be an important prerequisite for the generation of technological knowledge" (BMBF 2010:4). The strategy also calls for a public dialogue on innovation, so that the High Tech Strategy 2020 may further develop based on the results of discussions between multidisciplinary researchers aiming to achieve consensus on the "benefits and risks for individuals and society" of certain controversial technologies (BMBF 2010:12). Thus, the strategy certainly aims to create a dialogue between society (and "the working world"), academia, business, and government, but specific measures to begin and facilitate this public dialogue are not described.

NIS approach to innovation towards SD

Within the five fields of action, the German innovation strategy lists innovation focus areas that are clearly drawn up with the goals of SD in consideration, such as: CO₂-neutral, energy-efficient and climate adapted cities; intelligent restructuring of the energy supply system; renewable resources; optimized diets; capabilities for independence for the elderly; increasing internet use while decreasing energy consumption; effective treatment of illness with individualized medicine, and more (BMBF 2010:6-8). These goals are optimistically titled "forward-looking projects", and some are followed by concrete lines of action. In the energy field, concrete initiatives such as the 6th Energy Research Programme of the Federal Government and a framework program on "Research for SD" prove the German strategy to move past conceptual guideless for innovation for SD and into a strategic action plan. The BMBF will address a number of SD concerns (technology, the environment, and the economy specifically) and is already set to be advised by a Bioeconomy Research Council (BMBF 2010:12-13). While a broad SD framework does not envelop the High Tech Strategy 2020, particularly in comparison to the French NIS, there is still specific, tangible evidence within the "forward-looking projects" that innovation goals both consider and further SD goals in the German NIS.

Actions and measures of the innovation strategy

While the German strategy distinguishes and describes five specific fields of action in which innovation should take place, and within those fields it takes a "mission-oriented approach", suggesting "forward-looking projects" (as mentioned previously) to be further developed or carried out (BMBF 2010). However, many of these projects appear to be a list of needs or desired goals without immediate steps for action, aside from some of the specific projects listed above. Aside from the energy actions previously mentioned, specific actions include the 3rd Mobility and Transport Technologies transport research programme and the National Aeronautics Research Programme in the realm of mobility; and the Federal Government's ICT Strategy 2010, the development of smart grids, and the initiation of a public dialogue on cultural issues related to the internet in the realm of communication (BMBF 2010). The energy, mobility, and communication-related fields of action are particularly more concrete than those related to health, in which listed actions are more along the lines of recommendations or research goals. Considering that the High Tech Strategy 2020 simply ends at the end of the description of the communication-related projects, it seems that a final synthesis is needed in order to lay out general, immediate policy steps that could be

taken to support general innovation as well as the listed specific projects within the five fields of action.

3.4 Netherlands

Background and objectives of the innovation strategy

In the Netherlands, the document recognized as the official National Innovation Strategy is titled “Towards an agenda for sustainable growth in productivity”, released by the inter-departmental Knowledge & Innovation (K&I) programme in 2008 as a long term strategy delineating visions for Dutch innovation until 2030. K&I is meant to bring together the Ministry of Economic Affairs (EZ) and the Ministry of Education, Culture, and Science (OCW) (European Commission 2009d). K&I also implements the project “Nederland Ondernemend Innovatieland” (NOI, “Netherlands, land of entrepreneurship and innovation”). The strategy document begins by describing a vision and perspective for national innovation, then details ambitions up until 2030, goes deeper into objectives and actions, and then presents a policy perspective for up until 2030. The overall approach of the document is to outline a vision for 2030 and then review what tangible actions are necessary in order to achieve that vision.

Institutions and diverse stakeholder participation

The Dutch NIS recognizes a need for innovative governance in support of an innovative nation, stating their hope for a government that “not only supports innovation in every possible way, but also innovates itself” (K&I 2008:8). The innovation strategy is also not seen as separate from other government programs, such as the Clean and Green Programme, other environment and energy programs, and the Industrial Policy Statement, which are listed as related programs in which there is room for coordination (K&I 2008:8).

Within the government, actors in the innovation system are also diverse: the K&I programme directorate involves the Ministry of the Interior and Kingdom Relations, the Ministry of Defense, the Ministry of Economic Affairs, the Ministry of Justice, the Ministry of Agriculture, Nature and Food Quality, the Ministry of Education, Culture and Science, the Ministry of Social Affairs and Employment, the Ministry of Housing, Spatial Planning and the Environment, the Ministry of Health, Welfare and Sport, and the Ministry of Transport, Public Works and Water Management. Many such ministries develop their own innovation strategies, but have smaller budgets for this purpose in comparison to the EZ (European Commission 2009d:14). The combination of diverse government ministries, intermediary actors,

NIS approach to innovation towards SD

Like the previously mentioned NIS documents, the Dutch strategy first acknowledges that innovation can solve the jointly social and economic issues of climate change, an ageing population, the exhaustion of natural resources, loss of biodiversity and environmental pollution (K&I 2008). Sustainable growth is seen as the ultimate goal, with innovation being the key—thus, framing innovation within the context of SD. The document specifically addresses social innovation agendas as part of the NOI project (K&I 2008). In fact, the Dutch government dedicated €90m for these social innovation agendas through K&I. Such a

commitment to specifically social innovation policy actions is not seen in the previously mentioned strategies, which incorporate social development as a SD-based ethical framework without a concrete agenda.

The vision for 2030 in particular is described as specific to sustainable growth rather than the "whole socio-economic arena" (K&I 2008:8). Yet there is an overall, strongly repeated emphasis is on the potential unity of social and economic goals through both social and technological innovation, making the strategy well-seated within the framework of SD. The idyllically described vision for the Netherlands is undoubtedly an utopian one that meets all the tenets of SD, and the entire NIS is deeply embedded in the framework of SD, as with the French NIS. However, both of these national strategies, despite their ideal linkages between innovation and SD, share a lack of concrete future objectives and actions to implement those two national goals. Yet the Dutch strategy stands out in its deep, already strongly funded commitment to a social innovation agenda.

Actions and measures of the innovation strategy

Since the 2008 strategy, the Dutch government has initiated more public investments in renewable energy and energy efficiency technology (European Commission 2009d). Despite a strong grounding in the SD framework, Dutch innovation policy was hindered by the report's lack of improvement in R&D Expenditure in 2009 (European Commission 2009d). Regardless of strong linkages between innovation and SD, SD innovation will not occur without proper funding. In general, a stronger political commitment to R&D funding is called for (European Commission 2009d).

4 Current and future challenges at the European level

Recent innovation policy initiatives show a conceptual progress in identifying environmental innovations beyond R&D measure, tackling also organisational, societal and technological innovation. All of the numerous and recently adopted concepts, tools and policy initiatives (e.g. eco-efficiency, industrial ecology, life-cycle management, integrated product policy, extended producer responsibility, circular economy, sustainable materials management, low-carbon economy or the 3R of 'reduce, reuse, recycle') have a similar ultimate objective of decoupling economic growth and development from resource use and its related environmental impacts – and of promoting innovation as a means to reach that goal. Nevertheless, they also share a number of future challenges towards eco-innovation for SD:

- **Better specification as to what extent eco-innovations can change the way economies and societies use resources and environmental services.**
- **Better identification of the specific types of eco-innovation** that would be the most **relevant ones for contributing to radical changes** (as mentioned in chapter one, there are many types of eco-innovation, but only few of them have the potential to contribute to radical changes).
- **Better distinguish between radical and incremental innovation** and their impacts on the economy, society and the environment.

- The **role of organisational and societal innovations** (change in customer behaviours and consumers lifestyle) should be **better linked to the eco-innovation debate**.
- Specification of the **drivers and barriers to eco-innovations should be better specified**. The specification of the drivers and barriers is related to a policy paradigm (see the first chapter of this QR). This paradigm often implicitly frames and shapes the development and the implementation of the innovation policy and it defines its direction (economic growth or environmental friendly economic growth) and the instruments.
- **Better identification of the policy mixes and their instruments** for innovation towards sustainable development is needed.
- Implementation could be improved by providing **more concrete actions and measures** in the EU Innovation Union Roadmap to guide Member States and to **integrate** the different dimensions and types of eco-innovations.

References

Baker S. (2006): *Sustainable development*. New York: Routledge.

Bleischwitz R., Giljum S., Kuhndt M., Schmidt-Bleek F. et al. (2009): *Eco-innovation: putting the EU on the path to a resource and energy efficient economy*. Wuppertal Spezial 38. Wuppertal: Wuppertal Institut.

BMBF (Federal Ministry of Education and Research) (2010): *Ideas, Innovation, Prosperity: The High-tech Strategy 2020 for Germany*, http://www.bmbf.de/pub/hts_2020_en.pdf.

Burns, T. and Stalker, G. M. (1961) *The management of innovation*. London: Tavistock.

Dalglish C and Newton C. (2002) The relationship between firm survival and innovation: an introduction to the literature [review], *Innovation: Management, Policy and Practice* 4 (1/3): 209-214.

David, P. (1985): Clio and the economics of QWERTY. *American Economic Review* (75): 332-337.

Del Rio, P., Carrillo-Hermossilla, J., and Könnöla, T.(2010): Policy strategies to promote eco-innovation; an integrated frame work, *Journal of Industrial Ecology* 14 (4): 541-557.

Duchin, F.(1999): *Reducing pressures on the environment: forward-looking solutions and the role of formal models* In: Hemmelskamp, J., Leone, F., Rennings, K.(EDs.), *Innovation-oriented environmental regulation: Theoretical Approaches and Empirical Analysis*. Physica Verlag, Heidelberg, New York.

Enkel,E., Gassmann, O. and Chesbourg, H. (2009): Open R&D and open innovation: exploring the phenomenon, *R&D Management* 39 (4): 311-315.

European Commission (2009): *European Innovation Progress Report 2009*, DG Enterprise and Industry. Pro-Inno Europe Policy Trendchart.

European Commission (2009a): *Inno-policy trend-chart: Innovation policy progress report-Finland 2009*. DG Enterprise.

European Commission (2009b): *Inno-policy trend-chart: Innovation policy progress report-France 2009*. DG Enterprise.

European Commission (2009c): *Inno-policy trend-chart: Innovation policy progress report-Germany 2009*. DG Enterprise.

European Commission (2009d): *Inno-policy trend-chart: Innovation policy progress report-Netherlands 2009*. DG Enterprise.

European Commission (2010): *Europe 2020 Flagship Initiative Innovation Union*. Com(2010)546 final.

Fagerberg, J. (2003) *Innovation: A Guide to the Literature*, Paper presented at the Workshop "The Many Guises of Innovation: What we have learnt and where we are heading", Ottawa, October 23-24, 2003.

Finnish Government (2009): *Government's communication on Finland's national innovation strategy to the parliament*, http://www.tem.fi/files/21010/National_Innovation_Strategy_March_2009.pdf.

French Ministry for Higher Education and Research (2010): *National Research and Innovation Strategy, General report 2009*, http://media.enseignementsup-recherche.gouv.fr/file/S.N.R.I/28/7/SNRI_rapport_general_GBdef_158287.pdf.

Gjoksi, N. & Sedlacko, M. (2011): *Resource policies in the context of sustainable development: Current trends and challenges ahead*, ESDN Quarterly Report March 2011: <http://www.esdn.eu/?k=quarterly%20reports>.

Godin, B. (2009): National Innovation System: The System Approach in Historical Perspective, *Science, Technology and Human Values*, 34 (4): 476-501.

Hellström, T.(2007): Dimensions of environmentally sustainable innovation: the structure of eco-innovation concepts. *Sustainable Development* 15: 148-159.

Hines, F. and Marin, O.(2004): *Editorial building innovations for sustainability: 11th international conference of the greening of industry network*, *Business Strategy and Development* 13: 201-208.

Huber J. (1982): *The lost innocence of ecology: new technologies and super-industrialized development*. Frankfurt am Main: Fischer Verlag.

Husemann, M.H (2003): The limits of technological solutions to sustainable development. *Clean Technology and Environmental Policy* 5: 21-34.

IEEP (2011): *EU Natural Resources policy: Signposts on the roadmap to sustainability*. Directions in European Environmental Policy No. 2.

K&I (2008): *Towards an agenda for sustainable growth in productivity*, Ministry of Economic Affairs and Ministry of Education Culture and Science.

Kantner, R. M. (1988) Three tiers for innovation research, *Communication Research*, 15: 509-523.

Kay, J. (1993): *Foundations of Corporate Success: How business strategies add value*. Oxford: Oxford University Press.

Kemp, R. (1994): Technology and the transition to environmental sustainability: the problem of technological regime shifts, *Futures* 26: 1023-1046.

Klemmer, P., Lehr, U., and Löbbecke, K. (1999): *Environmental innovation* volume 3 of publications from a Joint Project on innovation impacts of environmental policy instruments. Synthesis Report of a project commissioned by the German Ministry of Research and Technology, Analytica-Verlag, Berlin.

Lambooy, J. (2005): Innovation and Knowledge: Theory and regional policy. *European Planning Studies* 13(8):1137-1152.

Martin, H. (2011): *Eco-Innovation Action Plan*, Presentations on the Green Week, 24-27 May 2011, Brussels: http://www.greenweek2011.eu/sites/default/files/2-2_Herve%20Martin.pdf.

Mol A.P.J., Sonnenfeld D.A. & Spaargaren G. (eds.) (2009): *The ecological modernisation reader: environmental reform in theory and practice*. London and New York: Routledge.

Murphy, J. and Gouldson, A. (2000): Environmental policy and industrial innovation: integrating environmental and economy through ecological modernization. *Geoforum* 31(1): 33-44.

Nill, J. and Kemp, R. (2009): Evolutionary approaches for sustainable innovation policies: from niche to paradigm? *Research Policy* 38 (4):668-680.

Ramadani, V. and Gerguri, Sh. (2011): Innovations: Principles and Strategies. *Strategic Change* 20: 1001-110.

Ramstad, E. (2009): Expanding innovation system and policy- an organizational perspective. *Policy Studies* 30(5): 533-553.

Rennings, K. (2000): Redefining innovation-eco-innovation research and the contribution from ecological economics, *Ecological Economics* 32:319-332.

Rogers, E.M. (1983): *Diffusion of Innovations*. The Free Press: New York, USA (3rd edition).

Romer, P.M. (1986): Increasing returns and long-run growth, *Journal of Political Economy* 98: 71-102.

Schmidt-Bleek F. (1998): *Das MIPS Konzept – Faktor 10*. Munich: Droemer.

Schumpeter, J. (1942): *Capitalism, Socialism and Democracy*. New York: Harper & Brothers.

Simmonis U. (1989): *Ecological modernization of industrial society: three strategic elements*. International Social Science Journal 121.

Smith, A., Voß, J. and Grin, J. (2010): Innovation studies and sustainability transitions: the allure of the multi level perspective and its challenges. *Research Policy* 39: 435-448.

Solow R. M. (1957) Technical Change and the Aggregate Production Function, *Review of Economics and Statistics*, Vol. 39: 312-320.

Vollenbroek, F. (2002): Sustainable Development and the challenge of innovation, *Journal of Cleaner Production* 10: 215-223.

von Weizsäcker E.U., Lovins A.B. & Lovins L. H. (1995): *Factor four: doubling wealth, halving resource use*. The new report to the Club of Rome. London: Earthscan.

UNU-MERIT (2011): *Innovation Union scoreboard 2010: the innovation's union performance scoreboard research and innovation*. Maastricht Economic and social Research and training centre on Innovation and Technology.

Whitelegg, K. and Ömer-Rieder, B. (2005): *Integrating sustainable development and innovation policy*, Austrian case for the OECD Nis Monit Working Group, Technology Information policy consulting, Vienna.