

## Creating cultures of sustainable innovation

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**Abstract.** Sustainability has become one of the main drivers of innovation and many regions in the world aim to transform into a 'sustainable innovation region'. Culture is an essential element of the innovation environment in sustainable innovation policies. This article discusses recent insights in the theoretical and empirical foundation of innovation policies aimed at developing 'cultures of sustainable innovation'. A multidisciplinary approach based on the dilemma paradigm of enquiry is used to develop a dynamic framework on how to foster sustainable innovation. The approach is applied in an assessment of the sustainable innovation culture in two regions: Silicon Valley and Southeast Netherlands. It is concluded that Regional Innovation Systems can be assessed by evaluating to what extent a dynamic balance is established on each of the innovation culture dilemmas. However, copying 'success formulas' for sustainable innovation from other regions is impossible. The dynamic balance depends on history and culture of the region and the continuous interaction with the external environment.

**Keywords.** Innovation, sustainable development, regional culture, cultural geography, policy, regions in The Netherlands

### 1 Introduction

Many aspiring innovative regions have tried to copy the success of Silicon Valley, often replicating the magic word 'Valley' in their regional 'brand'. Even a small country like The Netherlands has a Seed Valley, Health Valley, Food Valley, Energy Valley, Media Valley and Maintenance Valley. The recipe for regional innovation policies seems to be to emulate the success factors of Silicon Valley as an innovative region as reported in the extensive literature on the region, e.g. proximity, collaboration and sharing knowledge, high quality of life environment, entrepreneurial mindset and the presence of excellent research universities (Kenney, 2000; Lee et al., 2000; Wang and Horowitz, 2012). In recent years many regional innovation policies have failed with as a result skepticism about policies aimed at fostering innovation. Therefore, it is one of the main challenges in research of innovation to develop a framework underpinning innovation policies by a theoretically and empirically founded vision on the innovation process.

Innovation theory has shifted over time from the linear view on innovation (a straight line from science and technology to innovation) to a non-linear and more dynamic view. The latter requires taking into account interactions between a range of factors in the wider innovation system, such as entrepreneurship, diversity of ideas, cooperation, marketing, design, attracting and developing human capital, governance and the organization of innovation. It is getting increasingly important to incorporate

conditions of sustainability in innovation theory. Environmental changes and other sustainability issues act as a catalyst to innovation and it is even argued that sustainability has become the key driver for innovation (Nidumolu, 2009). 'Sustainable innovation' is not just about generating company profits, it aims to benefit the company as well as its stakeholders by finding a balance between '*People, Planet and Profit*'. Innovative companies need to be able to recognize societal and environmental challenges and to find creative ways to address these challenges in such a way that it provides long term value for society (people), long term value for the environment (planet), and sustainable business (profit).

A multidisciplinary approach is critically important to develop successful innovation policies (Boekema et al., 2000, p.81). Prud'homme van Reine (2011), building further on Cooke (2007), argues that regional innovation policies need to address:

The socio-cultural environment: identity and cosmopolitanism, attracting talented human capital, sustainable development,

The economic environment: stability and change in clusters and value chains, technological development and interaction with markets and end users, cooperative and competitive attitudes,

- The institutional environment: knowledge infrastructure, governance, financial infrastructure.

In this article a multidisciplinary approach based on the dilemma paradigm of enquiry will be used to develop a framework on how to foster sustainable innovation. Following Jorna et al. (2004), the concept 'sustainable innovation' will be used here in a wider context than just innovation aimed at developing sustainable services, products and production/manufacturing processes. It also encompasses organizing innovation processes in such a way that sustainability becomes a basic attitude, or in other words, creating a sustainable innovation culture (Hautamäki, 2010).

## **2 Innovation dilemmas and regional innovation systems**

The innovation dilemma approach (Prud'homme van Reine and Dankbaar, 2009, 2011a, 2011b) is a promising framework to understand innovation processes because it acknowledges the dynamics of the innovation process and allows for addressing interactions between a wide range of factors in the innovation system. In the innovation dilemma approach, creating innovation cultures is seen as a continuous process of finding a dynamic balance in a number of 'fields of tension', which can be described by innovation dilemmas. Tensions exist e.g. in generating ideas, in interactions between actors in the innovation process, in attracting talent, in organizing innovation, in governance of innovation, in short versus long time perspectives and change versus continuity. The innovation dilemmas can be derived from an analysis of the fundamental cultural dilemmas identified in models to assess national, regional and corporate cultures (Hampden-Turner and Trompenaars, 2000; Trompenaars and Prud'homme van Reine, 2004; Trompenaars and Hampden-Turner, 2010). In the dilemma model of culture, corporate cultures, regional cultures and national cultures are characterized by how they handle a number of fundamental cultural dilemmas. The cultural dilemmas can be translated to nine innovation culture

dilemmas at the level of corporate cultures (Prud'homme van Reine and Dankbaar, 2009), where they show up in the practices of innovative companies, e.g. in how Toyota manages contradictions in its innovation process (Takeuchi et al., 2008) and at the level of regional cultures (Prud'homme van Reine and Dankbaar, 2011a) where the innovation dilemmas show up in how various stakeholders try to balance tensions in regional innovation systems (Prud'homme van Reine and Dankbaar, 2011b). This article focuses on regional innovation cultures. The following nine dilemmas have been identified as a comprehensive set to characterize regional innovation cultures (Prud'homme van Reine and Dankbaar, 2011b):

The dilemma in generating ideas for innovative products and services: technology/knowledge driven versus user/market driven innovation. It can be seen in the tension between innovation based on recognition of technical potential versus involvement of 'lead users' and 'customer innovators' in the development of innovative custom products (Thomke and Von Hippel, 2002).

The dilemma in the interaction between innovative companies: open innovation in cooperative, trust-based relationships versus closed innovation in competitive relationships. It can be seen in the tension between proximity to ensure effective communication and common understanding and distance to avoid lock-in (Boschma and Frenken, 2011).

The dilemma of creativity versus control: regional innovation led by (often small) creative companies versus regional innovation led by (often large) process driven companies. It can be seen in the tension between dominance of large, resourceful 'anchor' firms (Agrawal and Cockburn, 2003) versus small firms which can be more risk taking, pioneering and fast moving (Florida and Tinagli, 2004).

The dilemma in the regional knowledge infrastructure: focus on fundamental research versus focus on application oriented R&D and entrepreneurial activities. It can be seen back in the tension that is often described as 'the knowledge paradox' (Boekema et al., 2000): high investment in good quality fundamental research, but insufficient economic returns.

The dilemma in attracting innovative knowledge workers to a region: high quality of life versus thriving business climate. It can be seen in how highly mobile knowledge workers balance economic opportunity and lifestyle considerations in selecting regions to live and work (Florida, 2002).

The dilemma in governance of innovative regions: participative culture versus decisive leadership. It can be seen in the tension between consensus building between a broad spectrum of actors versus taking top-down decisions in governance of innovation systems (Heidenreich and Koschatzky, 2011).

The dilemma of internal dynamics versus cross-border connections: Strong identification with the own regional culture and confidence in traditional innovation strengths versus stimulating innovation by openness for cultural diversity and utilizing a heterogeneity of perspectives. It can be seen in the need to balance 'local buzz' (role of learning processes between actors embedded in a local community in the regional innovation processes) and 'global pipelines' (role of knowledge acquired via global communication channels in the regional innovation process) in innovative regions (Bathelt et al., 2004).

The long term versus short term dilemma: innovations aimed at short term efficiency and profit versus innovation aimed at transformative innovations offering long term solutions for societal and ecological problems. The tension behind this dilemma has even been acknowledged by usually short term oriented venture capitalists: icon venture capitalist John Doerr said in a lecture about climate change and investment (TED Talks series 2007) that he is turning his focus toward innovation in green technologies 'to create a world fit for his daughter to live in' and announced the foundation of a high profile Greentech Innovation Network.

The dilemma of continuity versus change: regional specialization versus diversification. It can be seen in the tension between focus on innovation in dedicated clusters based on past development trajectories versus innovation focused on future potential divergence (Harmaakorpi, 2011).

The strength of an innovation culture is determined by to what extent both sides of the dilemma are connected to each other. The energy is in the tension between the extremes, and the energy that is released by making the connection can act as the driver for change and innovation. Successful regions develop change competence to cope with the dynamic environment, by a continuous process of finding a dynamic balance in each dilemma in a joint effort by various stakeholders (Prud'homme van Reine and Dankbaar, 2011a, b).

The dilemma approach fits in with the regional systems of innovation (RIS) approach, which conceptualizes economic systems as webs of interrelated institutions in a dynamic context in which innovation is the driving force of economic change (Cooke et al., 2004). Tödtling and Trippel (2011) define regional innovation systems as strongly interacting knowledge application/exploitation and knowledge generation diffusion subsystems in a common socio-economic and cultural setting. This implies that the effectiveness of a RIS is influenced by cultural values. A successful RIS requires the development of a distinctive 'regional innovation culture': the pattern of norms, values, attitudes, conventions, perceptions and assumptions that influences the innovation processes of companies in the region. This regional innovation culture is shaped by regional institutional and regulatory structures and in turn shapes how companies interact with each other in the regional innovation system (Asheim and Coenen, 2005). In the dilemma approach, a regional innovation culture is characterized by how the nine regional innovation culture dilemmas are handled.

In the following, the innovation dilemma approach and the systems of innovation approach will be combined into a multidisciplinary approach to understand the impact of regional innovation policies on creating cultures of sustainable innovation.

### **3 Sustainable innovation**

The RIS approach provides a viable theoretical foundation for an approach which includes a wide range of issues relevant for innovation, including sustainability. This is because it sees innovation systems as complex systems in which private and public institutions are linked. Johnson and Lehman (2006) use the term 'sustainable innovation systems': innovation systems in which knowledge is developed and applied that helps to decrease the negative impact of production and consumption

patterns on the environment and on society.

Culture is an essential element of the innovation environment in a sustainable innovation policy (Hautamäki, 2010). The link between sustainability and innovation processes & practices is in creating a culture of sustainable innovation (Vilanova and Dettoni, 2011): a culture that nurtures innovation and sustainability.

However, 'sustainable innovation' is a paradoxical concept. 'Sustainability' is often associated with stability and 'innovation' with renewal. E.g., Hautamäki (2010) argues that sustainable innovation is an essential element of business success as well as social stability in innovation regions. But sustainability can also be understood as a continuous process that requires a dynamic balance between (the emergence of) problems and the capacities to solve these problems. So, sustainable innovation is about a dynamic balance between positive and negative changes in the innovation system. The paradox of sustainable innovation could be described as 'the need to change in order to remain the same'. The dilemma approach to innovation is especially useful to get insight into the development of sustainable innovation regions, because this approach deals with the development of change competence by a continuous process of finding a dynamic balance in a number of fields of tension: tension between preservation of cultural elements in the innovation system that have contributed to success in the past and cultural elements which become visible in capacities and competences to find solutions for new societal and environmental problems. The tension between stability and change can be recognized in the innovation culture dilemmas listed above. Creativity, competition, entrepreneurship, decisiveness, diversity, transformation and diversification are associated with change. Cooperation, trust, process orientation, consensus, cultural identification, efficiency and specialization in traditional regional strengths are associated with stability. Sustainable innovation requires a dynamic balance between stability and change and the innovation culture dilemmas show that change and stability are indeed not mutually exclusive. The stability of cooperation and trust can form the basis for the willingness to change that fits with open innovation (Chesbrough et al., 2006). The stability offered by high quality of life can be the basis for pioneering activities of creative entrepreneurs (Florida, 2000). The stability of a consensus culture can result in fast implementation of change after all stakeholders had the opportunity to contribute (Heidenreich and Koschatzky, 2011). This suggests that innovation policies aimed at developing sustainable innovation cultures can be assessed by how they address the innovation culture dilemmas.

#### **4 Research**

Many innovation regions in the world aim to transform into a 'sustainable innovation region'. In Silicon Valley, the Sustainable Silicon Valley (SSV) initiative is a case in point (SSV 2013). SSV is a collaboration of regional government agencies, businesses and community organizations with the mission to guide the Silicon Valley community to a more sustainable future: an economically vibrant, environmentally healthy and socially equitable Silicon Valley. In The Netherlands, the region Southeast Netherlands (SEN), also known as the 'Brainport-region' (Brainport, 2011) has the ambition to develop into a sustainable innovation region. In the following the

innovation culture dilemmas will be used to assess how the challenges in the development of a sustainable innovation culture in these regions are addressed.

The assessment of how innovation dilemmas are handled in Silicon Valley in this article is based on an analysis of the extensive literature about this region (e.g. Kenney, 2000; Lee et al., 2000; Saxenian, 1994, 1999 and 2000; Saxenian and Hsu, 2001; Wang and Horowitz, 2012). The assessment of how innovation dilemmas are handled in the region Southeast Netherlands (SEN) is based on the results of empirical research in the region which will be described in the following.

SEN consists of the Southeast of the province of Brabant and the province of Limburg in The Netherlands. Its most important innovation centres are Eindhoven (with the open innovation campus HTCE, the University of Technology Eindhoven, and innovative high tech companies such as Philips and ASML), South-Limburg (with the Chemelot open innovation campus, the University of Maastricht and innovative companies such as life sciences/performance materials company DSM) and Helmond (with the Automotive open innovation campus). Characteristic for the region is the presence of a number of clusters in which innovative companies collaborate with knowledge institutes: high tech systems, performance materials, life sciences, energy, design, food technology, ICT and automotive. Environment, climate, clean energy, mobility and health are considered to be the most important sustainability challenges in the region. The results reported in this article build further on research conducted in the SEN-region in the period 2008-2010 within the scope of the CURE project (Corporate Culture and Regional Embeddedness). The main research topics in this project were innovation and sustainability. Results of this project on the topic of innovation have been reported previously (Prud'homme van Reine and Dankbaar, 2011a), however, the results on the topic of sustainability have not been reported in detail so far. The results on sustainable innovation in the SEN region were re-analysed and supplemented with recent research. The research in the period 2008-2010 consisted of 49 semi-structured in-depth interviews with companies and organizations involved in the regional innovation system, such as regional governments, chambers of commerce, regional development agencies, knowledge institutes and the management of open innovation campuses; participant observation at ten conferences and seminars in the region; and document analysis (studying documents on the regional innovation system and culture). Supplementary research was conducted in the period September 2011-February 2013 and consisted of twenty interviews with managers working at innovative companies in the region, including expats from Asia, East-, South-, West and North-Europa, South-America and North-America; participant observation at four conferences and seminars (presentation of the 'Brainport 2020' plan for the regional innovation system, seminar on regional innovation policy at the open innovation campus Chemelot, an international innovation workshop in Eindhoven and an 'open chemical innovation' workshop in the region); and updating the document analysis.

The research outcomes were analyzed by categorizing the interaction between both sides of each innovation dilemma by distinguishing the following patterns (Prud'homme van Reine and Dankbaar, 2011a): 'productive interaction' between both sides of the dilemma (synergy); 'one-sided emphasis' (neglecting the other side of the dilemma), 'disconnect' (no connection between the two sides of the dilemma) and 'negative interaction'.

## **5 Sustainable innovation culture: results per dilemma**

### **5.1 Technology/content driven RIS versus RIS driven by users and market needs**

This is the equivalent at the regional level of the well-known 'technology push' – 'market pull' dilemma. In a technology/content driven RIS, ideas for new products and services come mainly from internally driven engineers and researchers, often resulting in products and services with top technology, but little attention for design and low consumer friendliness. In RIS driven by users and market needs, ideas are generated by responsiveness to customer needs, and even mobilizing customer needs.

In a sustainable innovation culture, environmental and societal challenges are translated into innovative concepts such as ecological and health products and services which anticipate market needs. Regional innovation policy can stimulate this by making the region act as a 'launching customer' for products and services that offer solutions for sustainability issues.

#### **Silicon Valley**

In Silicon Valley, the role of 'technopreneurs' connecting technological to innovative business opportunities is crucial in developing a dynamic balance on this dilemma. A technopreneur is an entrepreneur who combines being technology savvy, creative, innovative and risk-taking with the ability to recognize customer needs. A technopreneur does not follow market trends but gathers insights into needs and desires of customers and uses technological expertise to set new trends. Apple co-founder Steve Jobs is the classic example of a Silicon Valley technopreneur. More recent examples are the founders of Instagram who emphasize that identifying the problems that people have with mobile photos was the hardest part for their successful venture - building the minimum viable product, getting vital customer feedback, building simple solutions instead of complicated solutions and bringing that simple solution to the masses came next. Technopreneurship is not limited to entrepreneurial firms in high technology areas. The concept can also be used for entrepreneurial firms in other sectors. Perhaps it is better to use the term 'expert entrepreneur': an entrepreneur who is able to bridge the 'content side of innovation' with the 'meaning side of innovation'. Developing an innovation culture requires stimulating expert entrepreneurship by providing a framework so that 'customer innovators' and 'lead users' can participate in the innovation process. In Silicon Valley, Google recently built the 'Google Experience Center', 'to share visionary ideas, and explore new ways of working' with its clients and business partners.

The innovation culture in Silicon Valley has benefited from the role of big contracting authorities as 'launching customer', especially defense contracts demanding innovative technology which could be transferred to commercial applications. Currently, similar productive interaction in the region between inventors, entrepreneurs, investors and the public sector results in the development and deployment of innovative solutions in the clean technology and renewable energy industry. Entrepreneurship is stimulated via the 'Clean Tech Entrepreneurship' course at Stanford University. At the demand side, the state of California takes a leadership role in enacting policies to create an early market for technology related to energy

efficiency, clean air and water and renewable energy. Examples are a policy plan to transform the Bay Area around San Francisco into the Electric Vehicle Capital of the U.S. and public-private cooperation in the East Bay Cleantech Corridor.

### **SEN region**

In the SEN region, the emphasis on this dilemma is on technological potential. An example is anchor company Philips, known for being technology oriented and product development driven with engineers dedicated to complexity. Philips appointed an outsider, Italian Andrea Ragnetti, as Chief Marketing officer in order to become more customer oriented. One of his first actions was to ask Philips managers to test their company's products at home in the weekend. Many returned to the office frustrated and admitted that the innovative products were too complicated for users. Ragnetti then introduced the slogan 'sense and simplicity' in an effort to direct innovation towards applications and solutions that are simple to use and make sense. However, when Ragnetti was forced to leave Philips in 2010, he was still a controversial figure at the company and Philips was still known as predominantly 'technology push' oriented.

Another example in SEN is the 'Phileas', an innovative and environmental friendly public transport system developed by the company APTS with regional industry leader VDL as most important shareholder. The Eindhoven city region acted as 'launching customer' of the Phileas, partly in order to strengthen the innovative image of the region. However, eventually the project reinforced the image that the region is too much technology focused. The Phileas is an electrically driven road vehicle with a large number of innovations in its original design, such as an automatic guidance system. The first prototype of the Phileas was a brilliant design but it faced many technical problems. Even the designers acknowledge that the design was perhaps too futuristic and incorporated too many new features in one product. In the next generation a number of innovations were eliminated so that the Phileas is now operational, but technically the system hardly differentiates itself from a normal city bus.

A lot has been done in the region to develop a more customer oriented culture, such as attention for design, but the regional innovation culture is still predominantly technology oriented, also in the field of sustainability.

### **5.2 RIS characterized by open innovation in cooperative trust-based relationships versus RIS characterized by closed innovation in competitive relationships**

In a culture characterized by cooperation and trust, knowledge sharing in networks facilitates open innovation. However, too much networking may lead to regional 'lock-in'. Competition is associated with competitive rivalry, resulting in motivation for innovation. However, lack of trust may result in lack of knowledge sharing, hampering the innovation process. In a sustainable innovation culture, companies and suppliers cooperate informally with the goal to have joint success with innovative solutions for societal problems, but a sustainable innovation culture must also be competitive to survive competition with other regions.



### **Silicon Valley**

Silicon Valley has been described as a flourishing regional innovation system by the combination of very competitive circumstances and co-operative attitudes (Saxenian 1994). Saxenian describes how Silicon Valley firms were successful by competing intensely, while networking and collaborating in informal and formal ways with one another. Leading innovative companies in the region such as HP and Intel are known for being very competitive but also open in partnerships to ensure that their innovations diffuse rapidly throughout the region and the industry.

This 'co-opetition' attitude is maintained in sustainable innovation as well. Many sustainability start-ups in Silicon Valley have only a small market share or only sell licences on research patents, but because of their competitiveness, larger companies feel compelled to cooperate. E.g., Silicon Valley electric-vehicle start-up Tesla has affected the automotive industry despite its small market share, because large car makers feel obliged to invest in electric-vehicle development and partner with a high profile company such as Tesla. Another example is how clean tech companies cooperate in lobbying for effective sustainability policies, in developing green technologies to accelerate sustainable innovation and in establishing the standards required to ensure that new technologies such as charging infrastructure for electric cars can be rolled out. An example of co-opetition in Silicon Valley is in the field of 'smart grids', the combination of innovative transmission equipment, innovative meters, and innovative software applications that all interact with each other to increase energy network efficiency. AutoGrid Systems, a Silicon Valley startup in 'big data' analytics for the electricity and energy industry, and Silver Spring Networks, a Silicon Valley based networking platform and solutions provider for smart grids, are competitors but also have a strategic partnership to jointly develop an innovative energy-saving demand optimizer solution for utilities, grid operators, service providers, and large power consumers.

Summarizing, there is positive interaction on this dilemma in sustainable innovation, because the need to work together to address sustainability challenges goes together with the need for urgency and innovation brought about by competition.

### **SEN**

The term 'friendly' is often used to describe the culture of the SEN region: it is relationship oriented, companies and suppliers share knowledge in formal and informal networks and innovation leaders are easily approachable. Regional policies aim to bring companies and other regional actors together by providing networking opportunities, creating network organizations, coordinating projects to stimulate co-operation and knowledge sharing and by creating places for competing companies to co-operate as partners in innovation: open innovation institutes which are often structured as public-private partnerships. The atmosphere on the open innovation campuses in the region fits with the tradition of networking and sharing. However, there is also criticism in the region itself: 'sometimes there is too much networking going on'. This means there is a risk of regional 'lock-in' and lack of innovation. The need for more competitive attitudes is felt in the region, but leads to a certain level of distrust: 'the old model of cooperation was based on trust, but now we have to sign extensive contracts'. This problem shows up especially in the life sciences sector, important for sustainable innovation. The background is a cultural difference between

how intellectual property is dealt with in different sectors. In the electronic industry, until recently dominant in the region, it was customary to exchange patents. In the life sciences industry, companies strive to get exclusive intellectual property rights, either by closed innovation or by obtaining patents via acquisitions. The region tries to solve this 'trust-issue' by finding creative ways to share Intellectual Property Rights and by encouraging knowledge institutes to take the lead in open innovation projects.

Summarizing: in the field of sustainable innovation, the regional innovation culture in the SEN region is dominantly cooperation and trust oriented.

### **5.3 The dilemma between creativity and consistency in regional innovation systems**

Room for creativity is necessary for entrepreneurs, designers, researchers etc. to generate inventive ideas for products and services. A culture of innovation requires entrepreneurial spirit, artistic freedom, tolerance for creative, committed and often eccentric people – or, according to 3M, the first company which claimed to have a culture of innovation, 'tolerance for tinkers'. Consistency is necessary to ensure the widespread use of these inventive ideas and products, e.g. engineering standards and innovation systems. A sustainable innovation culture needs the capability for 'disciplined creativity' – the will to continuously improve new concepts.

The debate about what type of companies contributes the most to innovation – big, resourceful companies or small, creative companies – dates back to the writings of Schumpeter (McCraw, 2007). The debate was recently revived by the claim that IBM's innovation processes make that 'IBM is better in creating a sustainable innovation culture than Apple has ever been or will be' (Fidelman, 2012). However, according to the dilemma model a sustainable innovation culture is based on connecting the strengths of creativity and discipline in the innovation process.

#### **Silicon Valley**

In Silicon Valley, the connection between the strengths of creativity and discipline can be seen in the interaction between small entrepreneurial companies and more process oriented large companies in the region, but also within companies. E.g. Intel is known as being open *and* authoritarian, Google is known for combining 'relentlessly experimenting' in a 'fun' work environment with discipline in support processes. Icon of creativity and innovation Apple benefited in its early days from the interaction with the Xerox research centre in Silicon Valley and is now known for combining creativity and room for imagination with disciplined project management. Currently, Xerox runs an 'Artists in Residence' program at its Silicon Valley based research centre based on the idea that by putting creative people together (artists with researchers), innovation will naturally emerge.

The culture of disciplined creativity is maintained in sustainable innovation as well. Silicon Valley based founder of the biotech industry Genentech is a case in point. It nurtures a culture that values innovation and has as its mission addressing significant unmet medical needs and making medicines that matter. It was known for its 'independent and free-wheeling culture of innovation' throughout its twenty years of partnership with the large pharmaceutical firm Roche, and maintains this culture after a full takeover by Roche in 2009.

## SEN

In the SEN region, the city of Eindhoven calls itself a 'creative biotope'. In reality the regional innovation culture is still dominated by large companies such as Philips and DSM. The risk of dominance of big companies is that they tend to specify innovation processes in so much detail, that creativity is stifled and a culture of avoiding risks develops. In the field of sustainable innovation, this has happened in the lighting industry. Philips Lighting was as a world leader in lighting also leading in innovation in compact, energy saving fluorescent lamps. For these type of lamps, a relatively slow innovation trajectory is acceptable because large investments are necessary for newcomers to gain a market position. When LED lighting came up, the pace of innovation in the industry increased rapidly and creative American and Asian companies could catch up with Philips Lighting, because speed was not the strength of the company and the region. Philips Lighting had to acquire smaller companies in LED-lighting in order to re-establish its leading position. In parallel, it started a culture change program under the name 'accelerate', with the goal to reduce complexity in the innovation process. Interestingly, one of the companies acquired by Philips was Silicon Valley based Lumileds Lighting, confirming the need to combine strengths of small and large companies in a sustainable innovation culture.

In the life sciences industry, dominance of large companies plays a role as well. Interviewees from smaller and medium sized companies (SMEs) report tension between dominant big players (Philips Healthcare, DSM) and SMEs notably in the field of patents. Big companies reportedly use their dominant position to claim intellectual property. A number of SMEs perceives that public-private partnerships in innovation programmes supports mainly big companies, which get access to intellectual property from the public domain but protect their own intellectual property.

The presence of big players with financial resources offers opportunities for small companies as well: participation in sustainable innovation projects that require large investments and cooperation with big companies in commercialization of sustainable innovations. However, in the current regional innovation culture, the dominance of large process oriented companies leads to one-sided emphasis on the consistency side of the dilemma.

### **5.4 RIS focused on fundamental research versus RIS focused on application oriented R&D**

The term 'knowledge paradox' refers to regions where this dilemma has not been resolved and high investment in good quality fundamental research results in insufficient economic returns, e.g. in The Netherlands (Boekema et al., 2000). In a sustainable innovation culture, investments in fundamental research are seamlessly connected to realizing innovative products and services that offer solutions for societal issues. The role of knowledge institutes is to help in building 'absorptive capacity': the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends, which is critical to its innovative capabilities (Cohen and Levinthal, 1990).

### **Silicon Valley**

The knowledge paradox doesn't apply to Silicon Valley. Especially Stanford University and its Research Park in Palo Alto played a key role in the emergence and growth of Silicon Valley as an innovation region by fostering creativity and entrepreneurship. Stanford graduates have founded innovative companies in the region such as Hewlett-Packard, Cisco, SUN, Yahoo and Google. The Stanford Technology Ventures Program (STVP) is dedicated to high-technology entrepreneurship education and research that provides new insights for students, academics and business leaders. It gives students the opportunity to get in touch with entrepreneurs, venture capitalists and consulting companies in the sustainability sector as well. In the field of sustainable innovation, Stanford focuses on cleantech and renewable-energy, in solar technology and low emission technology but also in innovation in the economics of the energy system, e.g. how to cost-effectively scale up solar power and other forms of renewable energy. Stanford graduates have contributed to sustainable innovation in the region by founding companies such as electric car company Tesla Motors and solar energy company SunPower. Examples of Stanford spin-offs are Nanostellar, a company developing materials for automotive emissions control, and Mango Materials, a company in innovative technology to produce biodegradable plastic from waste biogas.

In the area of social innovation, Stanford has also contributed to the foundation of innovative non-profit organizations in sustainability. An example is Kiva, co-founded by two Stanford graduates. Kiva is an innovative system that makes it possible for people around the world to loan small amounts of money to entrepreneurs around the world struggling to found often tiny businesses e.g. in clean energy and organic farming.

The positive interaction on this dilemma in Silicon Valley is apparent in how entrepreneurial university faculty members and students combine knowledge, intellectual passion and curiosity with awareness of commercial and societal implications of their research, thereby acting as a bridge between university and business.

### **SEN**

In the SEN region, the Dutch innovation paradox has been acknowledged and addressed by establishing research institutes and programs structured as public-private partnerships to bridge the gap between education, fundamental research, innovation and entrepreneurship. Top university research groups cooperate with companies to make the connection between fundamental research and development of products and services. These institutes and programmes are modelled after the open innovation concept and are largely based on the open innovation campuses in the region. Examples are CTMM (Centre for Translational Molecular Medicine) and BMM (BioMedical Materials programme): research programmes in the field of life sciences and biomedical materials in which academic hospitals are involved and therefore very relevant for sustainable innovation. The focus in CTMM and BMM projects is, however, on fundamental research. Product development and commercialization is out of the scope of these programmes. SMEs think more in terms of economic profit on the short term, and are therefore reluctant to participate.

A second approach to address the knowledge paradox is valorization of investments

in fundamental research by stimulating academic entrepreneurship. However, according to interviewees at the business side, the emphasis on valorization makes academic knowledge actually less accessible for companies because university spin-offs protect their unique knowledge and intellectual property. Moreover, universities are more distant from the market which makes it difficult to file good patents. The costs of scaling up and commercialization are often underestimated. In the SEN regional innovation culture, the knowledge paradox has not been completely resolved, so that a 'disconnect' between both sides of the dilemma is still present.

### **5.5 RIS characterized by high quality of life versus RIS characterized by thriving business climate**

This dilemma describes the tension between 'soft' quality of life and 'hard' economic factors. On the one hand, innovation is fostered by attracting the 'creative class' by focusing on soft issues: an attractive natural and urban living environment, vibrant cultural scene, good educational climate. However, a pleasant, friendly and relaxed region may also end up as a retirement haven. Focus on hard economic factors is necessary as well: opportunities to perform and achieve in business, such as availability of venture capital and infrastructure. But if a thriving business climate goes at the expense of quality of life, businesses may start seeking improved quality of life elsewhere for their innovation activities. In a sustainable innovation culture, sustainability challenges lead to commitment and job satisfaction because work serves a valuable purpose, which in turn helps in attracting and retaining talented people.

#### **Silicon Valley**

Silicon Valley's innovation culture benefits from the balance between economic opportunities and lifestyle considerations (Florida, 2002): an attractive green, safe environment; the inspirational urban environment and cultural facilities of nearby San Francisco; inspiring office architecture and office space e.g. Googleplex, in combination with a result oriented and achievement oriented culture and the presence of major venture capitalist companies resulting in a thriving business climate.

The emerging sustainable innovation sector contributes to positive interaction on this dilemma it adds to the attractiveness of the region because entrepreneurs and workers in sustainability sectors find additional motivation in working on tangible ('green') projects that are seen as worth your while to work for. Moreover, due to the attractiveness of the region for venture capital, a company has emerged that serves as icon of the sustainability industry: electric car company Tesla Motors.

#### **SEN**

In the SEN region, regional policies focus on the 'soft' side of this dilemma, enabling an attractive living environment: improve image/brand as innovative region; develop an attractive urban, green and safe environment and develop attractive open innovation campuses with iconic buildings which serve as symbolic capital for new ways of working and sustainable development. This emphasis can be explained partly by the scarcity of business talent: 'there are more ideas for innovative companies than entrepreneurial talent to take up these ideas and turn them into a success'. Another explanation is that the amount of venture capital available in the region is much less than in Silicon Valley. Several initiatives in the region which seemed to have the

potential to develop into a regional icon for sustainable innovation failed due to lack of capital or lack of a solid business case, e.g. Solland Solar (solar cells), Duracar (electric vehicles) and the Silicon Mine (raw material for solar cell manufacturing).

Philips and DSM try in their sustainability strategy to compensate the lack of venture capital by creating their own venture capital divisions, in order to bring in external knowledge and to find external paths to bring own technology to the market. For instance, Philips participates in a venture capital fund targeting innovative companies in health care and invests in the Philips Healthcare Incubator. DSM invests via its venture capital division in innovative companies in life sciences, biodegradable materials and sustainable energy.

The regional innovation policy is aimed at strengthening the 'hard' side of the dilemma by stimulating education in entrepreneurship, stimulating creative entrepreneurship and stimulating interaction between technologists and venture capitalists e.g. by organizing seminars with success stories of venture capitalists on the open innovation campuses.

However, in the current innovation culture, the 'soft' and 'hard' sides are still insufficiently connected.

#### **5.6 The dilemma in governance of RIS: participative versus decisive leadership**

Decisiveness in innovation policy leads to clear focus, but some stakeholders may feel excluded. Bottom-up involvement including public participation runs the risk of supporting too many initiatives in order to keep everybody satisfied. Innovation policy is about the orchestration of diverse, conflicting and competing interests (Cooke and Schwartz 2011) and requires a combination of decisive policy making and bottom up consultation and participation in program design. In a sustainable innovation culture, a clear vision from the region on sustainability serves as inspiration for bottom-up initiatives by entrepreneurs to take up sustainability issues.

#### **Silicon Valley**

The image of Silicon Valley is that of an innovative region based on bottom-up initiatives, but the influence of government policies on the regional innovation system in Silicon Valley is more important than often suggested. Especially high levels of spending by the Defense Advanced Research Projects Agency acted as a catalyst for the formation of high-technology firms in the region. Even Google originated from government-university collaboration, in a data mining program at Stanford University. The first Apple computer came into existence after the development of new processors in the semiconductor industry, facilitated by large-scale government procurement. In 1993, Joint Venture Silicon Valley JVSV was established, an organization bringing together leaders from business, including venture capital firms, government, academia, labour and the broader community, with the goal to provide analysis and action on issues affecting the region's economy and quality of life and work toward innovative solutions. In the field of sustainable innovation, the Advanced Research Projects Agency-Energy (ARPA-E) is inspired by the Defense Advanced Research Projects Agency. ARPA-E funds innovative and promising projects that have the potential to revolutionize energy technology for the next

generation and supports several renewable energy projects in Silicon Valley.

Still, in the current regional innovation culture the emphasis is more on bottom-up initiatives than on top-down guidance.

### **SEN**

The SEN region is proud on its 'triple helix' model of intensive cooperation between regional (semi) government agencies, business and knowledge institutes. However, the triple helix model has disadvantages as well. Cooperation in the triple helix can easily lead to a conflict avoiding consensus culture. A sustainable innovation culture requires being able to say 'no' to initiatives because of the limitations in innovative capacity. Especially expatriates working in the region express the view that too many initiatives are started in the region, while there is already a lack of resources for existing innovation projects. This leads to fragmentation of initiatives. E.g., the sub-region Limburg developed separate plans for innovative clusters 'Energy Hills' (solar energy cluster) and 'Health Valley' (health care) which turned out to be too ambitious.

SEN included sustainability in its vision for 2020 as a framework condition (Brainport, 2011), but within the region the view is expressed that the region should be much more decisive in making its mark in sustainable innovation (KPMG Advisory 2012). Summarizing, in the current regional innovation culture there is a strong emphasis on the participative side of the dilemma.

### **5.7 Strong identification with the regional culture versus leveraging cultural diversity for innovation**

Strong linkages and knowledge transfer at the local level results in the use of traditional strengths in innovation but limited connection to distant knowledge sources. Global connections and openness to cultural diversity allow for tapping into a wider knowledge base for innovation but may go at the expense of using traditional strengths in innovation. In a sustainable innovation culture, 'cross-border' connections are used to integrate diverse knowledge in the regional innovation system. Ideas in the field of sustainable innovation developed by immigrants or the foreign subsidiaries of regional companies are embedded in the innovation system and vice versa. The term 'reverse innovation' refers to the migration of innovations generated in emerging markets, e.g. Asia, to the world market, thereby translating the cultural influence of a region into products and impact on the world economy. Sustainable innovation benefits from 'brain circulation' (Saxenian, 1999, 2000) as a global channel for knowledge transfer (Hautamaki, 2010).

#### **Silicon Valley**

Silicon Valley has benefited from cultural diversity because immigrant entrepreneurs have contributed to the success of Silicon Valley as an innovation region and often maintained connections to Silicon Valley after migrating back to their country of origin (Saxenian and Hsu, 2001). 'Immigrants' are embedded in the regional innovation system as entrepreneurs, knowledge workers, managers, advisers and investors.

In the field of sustainable innovation, Silicon Valley benefits from the connection between identification with the regional culture and leveraging cultural diversity as

well. The originally Indian co-founder of Sun Microsystems, Vinod Khosla, serves as an example. After his career at Sun, Khosla became venture capitalist at the firm Kleiner Perkins and now has his own venture capital firm Khosla Ventures which focuses on investments in 'clean technology' and is also active in social entrepreneurship and sustainable energy.

### SEN

The SEN region is historically a peripheral region in The Netherlands and as a consequence still very much focused on its traditional regional identity in comparison with other innovation regions. Expatriates working in the region perceive SEN as insufficiently open for ideas from other cultures: 'there is still a lack of cosmopolitan atmosphere in the region'. However, the further internationalization process and establishing cross-border connections proceeds rapidly. International oriented companies and regional education institutes attract global talent to the region to stimulate the international atmosphere. Moreover, leading company Philips has embraced the 'reverse innovation' concept for a number of sustainable innovations. For example, Philips introduced worldwide health care products originally developed in India for the Indian market. Driving forces for sustainable innovation in this case are deployment of equipment at large distances of regular hospitals and affordability. Summarizing, the regional innovation culture in SEN shows limited productive interaction between identification with the own culture and openness for cultural diversity.

### 5.8 Innovations aimed at long term solutions for societal and ecological problems versus innovations aimed at short term economic profit

This dilemma is related to the shareholder – stakeholder dilemma: emphasis on short term shareholder interest versus emphasis on long term interest of stakeholders including society at large. In a sustainable innovation culture, innovations create long term value for society and the environment *through* generating short-term economic returns. A sustainable innovation culture requires availability of short term finance and long term finance and a sustainable financial infrastructure: a financial sector that stimulates, facilitates and supports the transition of the economic system to a sustainable, circular organized economy which serves mankind without depleting its living environment and resources.

#### Silicon Valley

Silicon Valley is renowned for venture capital funding aimed at maximizing short-term investment returns, which has promoted the emergence of the 'dotcom sector'. However, initiatives such as 'Sustainable Silicon Valley' have made that the balance of funding has shifted and the region's clean technology and renewable energy industry is rapidly attracting more funding. Silicon Valley's 'cleantech sector', sometimes dubbed Silicon Valley's 'new field of dreams', includes companies in biofuels (e.g. Solazyme, Codexis), electric vehicles (Tesla Motors), lighting (e.g. Lunera Lighting), solar (e.g. Solar City and SunPower), energy storage (e.g. Bloom Energy, a company that creates fuel-cell boxes that can power big data centres) and smart grid (e.g. Silver Spring Networks). Silicon Valley's venture capitalists are increasingly adding 'clean' or 'green' technology companies to their investment



portfolios, but investments in many failed to deliver the returns the investors expected. The question is, if they are willing to make even larger investments in disruptive innovations needed to solve environmental challenges.

Thanks to Silicon Valley's reputation in transforming innovations to big businesses it is seen as having the potential to take 'greentech' out of the domain of 'lifestyle' and subsidized projects. The following comments of an observer of Silicon Valley's sustainable innovation culture suggests that there is at least some productive interaction on this dilemma: 'We underestimate the importance of Silicon Valley's entrance into energy matters, but the reason isn't their technological knowledge or funding – it's cultural. Politically, Silicon Valley venture capitalists – as an idea, as paragons of American innovation – are potent, far more potent than more alternative lifestyle-linked green technologists' (Johnson, 2010).

### **SEN**

The SEN region supports and stimulates sustainability initiatives and has embraced the 'Cradle to Cradle' concept of sustainable design and innovation (McDonough and Braungart 2002). However, within the region there is some skepticism towards 'Cradle to Cradle', because the economic value is not always clear. The pioneer of Cradle to Cradle in the region is the company DSM. DSM's 'Climate induced innovation' initiative has realized innovations in renewable energy, biofuels, metal replacing composites that make means of transport lighter and energy-saving, and lacquers with environmental friendly solvents.

The regional innovation culture in SEN shows limited productive interaction on this dilemma.

### **5.9 The dilemma of continuity versus change of the regional innovation system: regional specialization versus regional diversification**

Specialization has the advantage of regional focus in innovation and exploitation of traditional regional clusters. However, too much specialization may impede radical innovations. Diversification means opportunities for cross-fertilization, however, a region cannot be world leader in everything. In a sustainable innovation culture, sustainable challenges act as a change agent for the innovation system. The idea of 'diversified specialization' is developing regional innovation platforms which connect past trajectories to future innovation potential aimed at solving societal and environmental needs. 'Regional innovation platforms' are future oriented and based on cross-fertilization between existing specialized clusters by making unorthodox combinations. Potential platforms are identified by exploring opportunities to create synergy at the interfaces of existing clusters.

#### **Silicon Valley**

Silicon Valley is mainly known for its high tech electronics cluster but in fact has multiple crosscutting and hybridizing innovation clusters at various stages of development. Building upon microwave technology in the 1950s, it developed its semi-conductor and electronics platform further to internet technology and a social media platform. A venture capital industry grew from successful development of the semiconductor and electronics platform. In turn, the venture capital industry was instrumental in creating a biotechnology cluster, building on academic research and

academic entrepreneurship at Stanford and the University of California, where the potential of the 'double helix' discovery was recognized, resulting in the invention of recombinant DNA, the key to realize the practical potential of DNA. This led to the foundation of Genentech, the forerunner of the regional biotech cluster.

The newly emerging sustainability platform in Silicon Valley is based on cross-fertilization between biotech, electronics, semiconductor, internet and social media clusters, again supported by the venture capital industry in the region. Summarizing, there is productive interaction on this dilemma in sustainable innovation in the Silicon Valley region.

### **SEN**

In the SEN region, a number of sustainable innovation platforms are being developed, all based on cross-fertilization between existing clusters:

- Smart mobility platform: Interface of High Tech Systems, Automotive, ICT and Design clusters
- Medical Technology platform: Interface of Life Sciences, High Tech Systems, Performance Materials and Design clusters
- Food for Life platform: Interface of Food Technology and Life Sciences clusters
- Smart grids platform: Interface of Energy, ICT and High Tech Systems clusters.

On this dilemma, there is productive interaction between continuity and change in the sustainable innovation culture in the SEN region.

## **6 Conclusions**

The nine innovation culture dilemmas can serve as a 'checklist' to prevent fragmentation of initiatives in regional innovation policies. Isolated initiatives such as creating an attractive cultural environment for the 'creative class' or attempts to create a sustainable innovation culture out of nothing have little chance of succeeding – the development of a sustainable innovation culture requires a joint effort in a wide range of issues by government, knowledge institutes, companies and financiers, and balancing top down policies with participative processes.

The focus in RIS theory and regional innovation policies has been rather one-sided with emphasis on continuity rather than change. Too much focus on continuity rather than change poses the risk of regional 'lock-in'. Examples are one-sided emphasis on proximity, collaboration and trust (IRE Working Group 2008: 15 - 'the functionality of a regional innovation system is essentially a matter of cooperation culture'), on the existing regional knowledge basis (Asheim and Coenen, 2005) and on stakeholder participation (Heidenreich and Koschatzky, 2011). More attention for dynamic elements in regional innovation systems such as connectivity, competition, achievement, diversity of ideas and change is necessary to increase the capabilities in RIS to find solutions for societal and environmental problems. Regional Innovation Systems should be seen as a dynamic environment in which knowledge, creativity and entrepreneurship are transferred into sustainable innovations.

The nine innovation culture dilemmas can be used for benchmarking Regional Innovation Systems in terms of how the dilemmas are handled. Copying 'success formulas' from other regions is impossible – the dynamic balance depends on history and culture of the region. However, an analysis of a specific region will reveal strength and weaknesses in innovation policies aimed at developing a sustainable innovation system. Competitiveness of a regional innovation system is determined by the weakest link. The preferred approach in regional innovation policies is not 'either – or' (focus on one of the extremes of the dilemma); not 'and- and' (addressing both extremes but not necessarily connecting them) but 'through-through' – connecting both sides of the dilemma in a continuous process of finding a dynamic balance in a joint approach by all stakeholders – there are no permanent solutions.

The analysis of how innovation culture dilemmas are handled in the Silicon Valley region shows positive interaction on most dilemmas, with the exception of dilemma 6 (one-sided emphasis on bottom-up initiatives and not enough attention for top-down guidance) and dilemma 8 (limited productive interaction: emphasis still too much on short term orientation side of the dilemma).

The analysis of the SEN region leads to the following results in terms of categories of how the innovation culture dilemmas are handled:

- 'One-sided emphasis' on one side of the dilemma while neglecting the other side. This is the case for dilemma 1 (dominant technology orientation) and dilemma 3 (dominant process orientation). In both cases, the explanation is in the history of the region: the dominant presence of large technology oriented companies such as Philips, DSM and DAF and a large university of technology. One-sided emphasis also holds in the case of dilemma 2 (emphasis on cooperation and trust, related to the traditional informal way of doing business in the region) and dilemma 6 (emphasis on participative culture at the expense of decisiveness), in both cases related to the abovementioned emphasis in regional innovation literature on cooperation, trust and participation. Developing a sustainable innovation culture with productive interaction on these dilemmas will require more attention for elements such as demand driven business models, speed, competition and decisiveness.
- 'Disconnect'. This is the case for dilemma 5 where actions in enhancing quality of living environment and in enhancing the business climate are not yet sufficiently connected. Although there are actions aimed at developing an attractive living environment and actions to stimulate entrepreneurship, there is perhaps too much involvement of the public sector in the activities of starting entrepreneurs and not enough acceptance of the fact that failures are part of a sustainable innovation culture as well.
- 'Negative interaction'. This is up to a certain point the case for dilemma 4. The Dutch 'knowledge paradox' is acknowledged in the region, but the current emphasis on knowledge valorization by universities makes academic knowledge in the perception of some SMEs actually less accessible. Perhaps universities are positioned too much as 'drivers' of the innovation system in publications about sustainable innovation.
- 'Productive interaction'. This is clearest for dilemma 9 which shows a dynamic balance between continuity (focus on regional specialization) and

change (regional diversification). The explanation for this is that the region has developed 'change competence' by the need to handle previous crisis situations such as the simultaneous problems at leading companies in the region Philips and DAF around 1990 and the experience of another leading company, DSM, with large transformations (from state mining company to privatized petrochemical company to life sciences company). As a result, the current economic crisis is seen as an opportunity to renew the innovation system and direct it towards sustainability. For dilemma 7, there is limited productive interaction. The history of the region as a peripheral region in The Netherlands results in a strong identification with the own regional culture, however, due to the presence of strongly international oriented companies in the region the openness for cultural diversity increases rapidly. For dilemma 8, there is limited productive interaction as well. Innovation aimed at long term solutions for sustainability issues ('people' and 'planet') has been taken on by companies in the region, but is still too much associated with idealism and subsidies instead of 'profit'.

Finally, it can be concluded that evaluating how innovation dilemma are handled provides a viable approach to exploring the dynamics of creating sustainable cultures of innovation. However, there are some limitations to this study due to the case study approach focusing on comparison of two industrial regions, one dominated by a few large companies and the other with a vibrant mix of large and small companies. Further research is necessary to assess the generalizability of the approach. Future research may focus on comparing regions with similar industrial sectors, on including regions in less developed countries, and on including regions where services or creative industries are dominant.

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